Popular Astronomy.

Vol. XXXI, No. 4 APRIL, 1923 Whole No. 304

REPORT ON MARS. NO. 25.

By WILLIAM H. PICKERING.

The Observing Staff.

In the preparation of this General Report on the observations made by the Associated Observers of Mars, during the apparition of 1920, we note with regret the absence from our contributors of Mr. L. J. Wilson, who has made such excellent drawings in the past. This fortunately is only temporary and in his place we have substituted from among our other contributors Dr. M. Maggini.

Opposition occurred on April 20, ☉ 122°.9, Martian Date July 41, diameter of the disk 15″.9. According to the plan formulated in our Report No. 8, the observers are divided into two groups, the drawings of each group being arranged according to the longitude of their stations, so that in general the views on the left were drawn a few days before those on the right (see Table I), but all the views in the same horizontal line represent approximately the same Martian longitude. The longitudes shown in successive lines are intended to differ from one another by 60°, beginning with 0°. Since each observer furnishes six drawings, his work for the planet is complete, and is represented on two pages. Besides the four principal observers, the work of five others is also shown. Only one of these sent a complete set of drawings, but the best examples of the work of the other four have been selected, and combined to form a sixth complete set. We are very glad to welcome Mr. Attkins of England, and Mr. Brindley of Australia as new observing members of the Associated Observers. The designations, location, and equipment of the nine observers are as follows:

Mg. Dr. M. Maggini, Florence, Italy. 9½-inch refractor by Amici. Magnification 318 and 500. Seeing on Standard Scale ranging from 8 to 11.

Pl. Rev. T. E. R. Phillips, Epsom, England. 8-inch refractor by Cooke and 12¼-inch reflector by Calver. Magnification 350 and 400. Seeing on Standard Scale ranging from 4 to 7.

Pk. Professor W. H. Pickering, Mandeville, Jamaica. 11-inch refractor by Clark. Magnification 330 and 430. Seeing on Standard Scale ranging from 6 to 12.

D. Professor A. E. Douglass, Tucson, Arizona. 8-inch refractor

by Clark. Magnification 220 and 350. Seeing on Standard Scale ranging from 6 to 10.

A. E. A. L. Attkins, Esq., N. Romford, England. 8½-inch reflector. Magnification 225, 350, and 525. Seeing on Standard Scale ranging from 5 to 9.

E. Rev. W. F. A. Ellison, Armagh, Ireland. 10-inch refractor by Grubb. Magnification 170 and 320. Seeing never really first rate.

Bk. R. N. Buckstaff, Esq., Oshkosh, Wisconsin. 8½-inch reflector by Mellish. Magnification 320. Seeing good.

Br. T. Brindley, Esq., Sydney, Australia. 8½-inch reflector by Calver. Magnification 200 and 360. Seeing fairly good.

T. H. Thomson, Esq., Epsom, England. 8-inch refractor by Cooke and 12¼-inch reflector by Calver. Magnification 325 and 300. Seeing poor.

The Two Ways of Representing the Surface of the Planet.

As is well known to those interested in planetary research, the modern observers of Mars are divided into two schools. One of these is represented in general by the leading members of the Associated Observers, the other we have designated in the past as the Lowellian School, after its founder. It has I believe heretofore been a mystery to nearly everyone how the same planet, Mars, seen under similar conditions by the two schools of observers, could appear so utterly unlike to them.

We think ourselves fortunate in having secured as a collaborator and colleague Dr. Maggini, who although he distinctly states that he does not accept the Lowellian theories of Mars, certainly represents by his drawings the work of the late astronomer in a manner surpassed by none. But not merely is he a keen sighted observer, but what is even more important, I have found him both willing and able to explain how he works, and why he represents what he sees as he does. He says for instance that he could make drawings of Mars closely resembling those of the other observers if he chose to do so. That is to say their drawings resemble the planet as he sees it. He prefers however to add to the general outlines and canals that he readily sees, certain other features which are extremely faint and difficult, so difficult in fact that in order to show them at all on paper their intensity must be greatly exaggerated,—exaggerated out of all proportion to the other detail. This of course destroys the resemblance of the drawings to the planet. This statement at once explains a good deal, and I believe really solves the question.

The writer in the past has insisted on several points which have a direct bearing on the matter here under discussion. He has stated for instance that there was no use in covering the whole surface of the planet with a confused network of canals, unless we were sure that they were really there. Also that even if they were there, the general

shape and intensity of the main features of the surface, which were subject to constant changes, seasonal and otherwise, was a matter of far greater consequence than the addition of a hundred or more insignificant canals. In other words we are likely to learn much more about the conditions on Mars by a study of these changes, and the changes in the forty or fifty major canals, discovered by Schiaparelli and his predecessors, than we are by a study of the scarcely visible innumerable minor canals depicted since his time. These minor canals, those of them that are really there, may perhaps teach us something, but they should not be permitted to overlie and conceal the clearly marked changing surface features of which we are certain.

Still another point on which the writer has especially insisted was that since near the limit of vision detail is very uncertain, and since it is better to leave out some general detail than it is to put in some that is not there, we should draw only those objects that we can hold in steady vision, and should omit all those that we can only glimpse. With the exception of Dr. Maggini this plan I believe has been followed by all the principal observers, those whose instrumental equipment is excellent and whose seeing is especially good. I have considered it important, since their work is harder to check than that of those working under less favorable conditions.

In emphasis of this point I may say that I have generally omitted Aryn from my drawings, although nearly all the other observers put it in. I represented it once in a very much shortened form in Report **17** Figure **2**, much as it was seen at the same time by Wilson, Figure 3. In 1914 and 1918 I refused to represent it at all. In 1892 it was conspicuous in Arequipa, and has been clearly seen the past year, now that Mars is again approaching the same position in its orbit. There is no doubt but that during the apparitions of 1914, 16, 18, and 20 it was an extremely difficult object, because its surface was then darkened, and it was accordingly lacking in contrast with the two bays on either side of it. It is also pretty certain that nobody would have drawn it or discovered it during those years if he had not known that it was sometimes visible there. Nevertheless one observer not associated with us has represented it as perhaps the most conspicuous object upon the disk! This does not strike us as good drawing, and we might say more.

While for those belonging to our school it is felt that the rule should be recognized, and followed, to draw only those features of the planet that can be held by the eye continuously, on the other hand we are very glad to publish along with our drawings those of a member of the other school, who has now become one of our prominent Associates, and who feels that he should draw everything that he sees, even if seen only by glimpses, so long as he believes that it is really there, and that he is representing it to the best of his ability. I think we can now more clearly understand why there are two ways of drawing

the markings on Mars, and in what precedes I have endeavored to explain why, and to represent the views of both sides as fairly as possible.

Characteristics of the Different Observers.

At the four oppositions of Mars from 1914 to 1920 the diameter of the planet ranged from 15″.0 to 15″.9. The magnification which appears best adapted to bringing out the finer surface detail with modern instruments of the most approved apertures, that is from 12 to 16 inches, seems to be about 400 diameters. With this magnification therefore the disk appears to be 100′ in diameter, or three times the size of the moon as seen with the naked eye. Owing sometimes in part to inferior seeing, and at others mainly to the properties of light itself, rather than to any imperfect construction of our telescopes, we are only occasionally, and at only the three nearer oppositions of the planet, able to see it any better than we can the moon with the naked eye. That is to say all the detail that we see may be considered as confined to a disk measuring one-quarter of an inch in diameter, such as the end of a lead pencil, held at a distance of two feet from the eye.

Now when it comes to dealing with such small details, the eyes of different observers differ greatly among themselves in their capacity for seeing different features. Some for instance can see finer markings than others, some on the other hand can distinguish fainter contrasts, while still others have a better sense of proportion. Thus Dr. Maggini has been able to draw more canals, and far more lakes than any other observer. Professor Douglass has been able to draw more canals that could be confirmed by others, and has no equal in the number of canals that he detects in the dark regions, while Mr. Phillips and Mr. Thomson draw the planet, showing the shape and appearance of its general features exactly as they appear to me, and because of this three-fold agreement I personally believe that their sense of proportion is the best. That is to say their's are the characteristics that would enable an artist to draw a portrait which should resemble the original. The four remaining observers work under less favorable conditions than the five above mentioned, and I think their drawings give the best idea of the planet as it would appear to the average amateur. Their work moreover has also a special importance which will appear later.

We thus see why it is important in giving a general discussion of the appearance of the planet at each succeeding apparition, to secure drawings from many different observers. This is the reason why we are glad to secure a representative of the Lowellian School, especially one who can talk, and explain what he sees, and why we are very glad that all our observers do not see and represent the planet exactly alike.

The changes which have been already recorded by our observers in the lakes, canals, and coarser surface details during these four apparitions have been in some respects very marked, much more so than,

outside of clouds and color effects, would have been seen by an equally distant observer in the case of our earth. Some of these changes we hope to describe in a future paper. Nevertheless the changes occurring in the next four apparitions, which will bring us back to the same Martian season as that with which we started, in 1914, will it is already known be greater still.

Description of the Drawings.

In Table I is given a statement of the main facts relating to the various drawings. The table is arranged as in previous Reports, the successive columns giving the number of the figure, the designation of

TABLE I.

Fundamental Data of the Figures.

Fig.	Obs.	Aper.	Magn.	Seeing	1920		Reg.	Long.	ΔLong.	Lat.	Diam.	☉	M. D.
								°	°	°	″	°	
1	Mg	9.5	318,500	10	May	3	A	355	— 5	+20.6	16.0	129.2	Jul. 54
2	Pl	8	350	—	May	9	"	0	0	21.3	15.7	132.1	Aug. 3
3	Pk	11	430	11	May	12	"	3	+ 3	21.6	15.5	133.6	Aug. 6
4	D	8	350	7,9	May	16	"	358	— 2	22.0	15.2	135.6	Aug. 10
5	Mg	9.5	318.500	8	Apr.	27	B	56	— 4	19.9	16.0	126.3	Jul. 48
6	Pl	8	350	5	May	4	"	44	—16	20.8	15.9	129.7	Jul. 55
7	Pk	11	430	6,9	May	6	"	63	+ 3	21.0	15.9	130.6	Jul. 56
8	D	8	350	8,10	May	11	"	60	0	21.5	15.6	133.1	Aug. 5
9	Mg	9.5	500	9	Apr.	24	C	122	+ 2	19.5	16.0	124.8	Jul. 45
10	Pl	8	350	6	Jun.	2	"	115	— 5	23.0	13.7	144.1	Aug. 27
11	Pk	11	430.330	12	May	1	"	120	0	20.4	16.0	128.3	Jul. 52
12	D	8	350	6.8	May	5	"	120	0	20.9	15.9	130.1	Jul. 55
13	Mg	9.5	500	10	Apr.	16	D	181	+ 1	18.4	15.7	121.0	Jul. 37
14	Pl	8	350	7	Apr.	19	"	182	+ 2	18.8	15.9	122.4	Jul. 40
15	Pk	11	430.330	10	Jun.	1	"	178	— 2	22.9	13.8	143.6	Aug. 26
16	D	8	220.350	7.8	Apr.	25	"	185	+ 5	19.6	16.0	125.3	Jul. 46
17	Mg	9.5	500	11	Apr.	8	E	246	+ 6	17.4	15.1	117.2	Jul. 29
18	Pl	8	350	4	May	19	"	238	— 2	22.2	15.0	137.0	Aug. 13
19	Pk	11	430	7	Apr.	20	"	238	— 2	18.9	15.9	122.9	Jul. 41
20	D	8	220,350	7,9	Apr.	22	"	241	+ 1	19.2	16.0	123.9	Jul. 43
21	Mg	9.5	318.500	9	May	6	F	305	+ 5	21.0	15.9	130.6	Jul. 56
22	Pl	8,12.2	350.400	6	May	14	"	290	—10	21.8	15.4	134.6	Aug. 8
23	Pk	11	430	10	May	19	"	305	+ 5	22.2	15.0	137.1	Aug. 13
24	D	8	350	8	Apr.	14	"	307	+ 7	18.1	15.6	120.1	Jul. 35
25	A	8.5	350	5.6	Jun.	13	A	4	+ 4	23.1	12.6	149.7	Aug. 37
26	E	10	170.232	—	May	7	"	356	— 4	21.1	15.8	131.1	Aug. 1
27	A	8.5	350.525	—	Jun.	6	B	71	+11	23.0	13.3	146.1	Aug. 31
28	E	10	170.232	—	Apr.	29	"	63	+ 3	20.1	16.0	127.2	Jul. 50
29	A	8.5	225.525	9	Jun.	1	C	117	— 3	22.9	13.8	143.6	Aug. 26
30	Bk	8	320	—	Jun.	12	"	111	— 9	23.1	12.7	149.2	Aug. 36
31	A	8.5	525	6.8	May	26	D	169	—11	22.7	14.3	140.5	Aug. 20
32	Br	8.5	200.360	—	May	9	"	200	+20	21.3	15.7	132.1	Aug. 3
33	A	8.5	225.525	7,8	May	19	E	248	+ 8	22.2	15.0	137.0	Aug. 13
34	T	8	325	—	May	22	"	232	— 8	22.4	14.7	138.5	Aug. 16
35	A	8.5	225.525	5,7	May	13	F	288	—12	21.7	15.4	134.1	Aug. 7
36	T	12.2	300	—	May	12	"	305	+ 5	21.6	15.5	133.6	Aug. 6

the observer, the aperture of his instrument, the magnifications employed, the seeing on the Standard Scale, the date of the drawing, the region depicted, the longitude of the central meridian, its deviation from the desired standard, the latitude of the center of the disk, the

angular diameter of the planet, the longitude of the sun as seen from Mars, and the corresponding Martian date, taken from Report No. **10**. The average date of the drawings was May 9, or 19 days after the opposition.

Observers' Remarks.

Dr. Maggini refers first to a bright projection or cloud that he observed over Edom Promontory on the night of March 24, and then to the white veil seen by all the observers over a portion of the Syrtis in April and May. He next gives a list of the 28 canals that he observed as double. They are as follows: Anian, Arnon, Casius, Cerberus, Chrysorrhoas, Deuteronilus, Erebus, Euphrates, Ganges, Gehon, Gigas, Granicus, Gyndes, Heliconius, Hiddekel, Iris, Jamuna, Marsyas, Nilokeras, Nilus, Orcus, Phison, Phlegethon, Protonilus, Pyriphlegethon, Tartarus, Thoth, and Xenius. Their duplicity lasted in some cases for a few days only, and in others for the whole duration of visibility of the canal. He states that the duplication is not due to the doubling of a single line, but rather to the addition of a new line to the original one. The space between the two canals is sometimes bright, sometimes dark gray.

In addition to the work of our regular observers, I have had the pleasure of examining some photographs of drawings made by Mr. G. H. Hamilton at the Lowell Observatory. On six drawings, coinciding nearly in longitude with our six regions, he identified for me the 15 following canals as being double: *Arnon*, Asopus, Astaboras, Callirrhoe, *Deuteronilus*, *Euphrates*, *Gehon*, *Gigas*, Nepenthes, Nilosyrtis, *Phison*, Pierias, Pyramus, Sitacus, and *Thoth*. Two of these, Asopus and Sitacus, are not recorded by Maggini. Of the remaining 13, seven were seen double by both observers. That is to say one-quarter of Maggini's and one-half of Hamilton's were confirmed. These names are printed in italics. It is noticeable that 5 of these 7 lay in region **A**. Maggini's remarks concerning the method of formation, and duration of the duplication, were independently described to me by Mr. Hamilton.

Mr. Phillips says he thinks it is of little use to observe the planet in England when it is south of the equator. He refers, as in a former article, to the fact that unless the seeing is very good indeed he prefers the 8-inch aperture to the 12-inch. It will be seen by Table I that he used the larger aperture on only one of his drawings this year. The most remarkable things that he noted were (*a*) the extension of the Syrtis in a westerly direction near Astusapes, (*b*) the appearance of a canal near Amenthes, [this was perhaps Triton], (*c*) the cloud lying near the polar cap May 21, which had moved off the next evening, but was still close to the limb. This may have been the forerunner of those snowstorms described and illustrated in our Report No. **23**. He refers also to the small size and faintness of the northern polar cap throughout the apparition.

What most impressed the writer was (*a*) the bright area visible over the Syrtis in March and April, (*b*) the broad, distinct, lightly shaded bands crossing the deserts in longitudes 0°, 60°, and 120° in early May, (*c*) the marked gulfs which had formed on either side of the northern point of the Syrtis, (*d*) the changes in the shape of Elysium, and (*e*) the snowstorms in June and early July that accompanied the disappearance of the northern polar cap and the formation of the large new one in the Martian August. These snowstorms have been already described in Report No. **23**. They are believed to have been snow, because they were bluish white rather than yellowish white like the clouds.

Elysium has of late years been so nearly circular in form that it is particularly well adapted to showing the shifting about of the canals over the surface, which is one of the most interesting and suggestive features of the planet's topography. There is no question but that in the earlier years of this century its shape was that of a very regular pentagon. This is proved by the drawings of numerous observers, as well as by photographs (see Report No. **22**). During the apparitions of 1914, 1916, and 1918 it was practically circular. On February 14 of 1920, ⊙ 92°.8, when central, it was drawn with considerable care to show its conspicuous ellipticity. The major axis lay in a meridional direction, and the relative length of the axes was in the ratio of 8 to 10. The major axis measured just one-quarter the diameter of the planet. In Report No. **22**, 3, the ratio for my drawing of Elysium when circular is given as 0.228 and for the photograph taken in 1907 as 0.222. On March 15, when central, only the preceding side of the ellipse was visible, but this was unusually strongly marked. On April 20 two drawings were secured showing marked irregularity in shape. One of these is represented in Figure 19. The form is now no longer elliptical but lemon shaped, with the major axis strongly inclined to the meridian. The form apparently changed appreciably during the two hours interval which separated the two drawings. This irregularity of shape is confirmed by the two drawings of Professor Douglass made on April 22 and 25 (see Figures 20 and 16). By this time a dark veil seems to have been drawn over the north preceding end of the figure. Elysium itself was not notably bright, and all three drawings show that the canals themselves had changed in shape and position, so that what was seen cannot be explained as merely due to a shifting cloud.

On May 19 and 22 (Figures 18 and 34), Messrs. Phillips and Thomson show the shape to be again nearly circular. Any marked irregularity of form is not likely to have been missed by these two skillful draftsmen. On May 28 the writer describes its shape as "far from circular," and draws it of a somewhat pear shaped form, with the stem on the south following side, much as it is shown by Douglass. A very fine canal crossing it is also noted. On May 29 it is again drawn

lemon shaped, with some fine canals and a minute lake situated near its center. This of itself proves not only that our seeing was excellent, but also that the effect shown is not due simply to a covering of cloud, which would have hidden the detail. By June 1 it appears to have been circular, but on July 2 markedly elliptical, with the major axis more nearly meridional than in Figure 19. July 5 it was according to the drawing nearly circular, but on July 8, $\odot_{,} = 163°.0$, again strongly elliptical, the major axis now lying more nearly east and west than in any of the other drawings. During the whole of the three previous apparitions it had appeared to me to be uniformly circular.

We conclude from these various representations and records that the canals are subject occasionally to irregular shifts of position, the change in the course of a few days, or less, sometimes amounting to nearly 200 miles. The observed changes occurred between the Martian dates June 33 and September 6. While these observations all corroborate the "shower track" explanation of the larger canals, and that these showers, owing to the low atmospheric pressure, occur practically every night, there is still much to be learned before we can consider this explanation as definitely proved. What we can say is that such rapid and extensive shifts are opposed to the hypothesis of vegetation, as applied to the more important canals, and favor an atmospheric explanation.

Regarding the canals, Professor Douglass writes, "I believe I only put down the canals I can hold, or see again and again. I have felt about the same confidence in the dark region canals as in the light, barring only the fact that other people do not seem to see them. I only get them when I look for them deliberately, just as I do for the light region canals."

Mr. Attkins refers to the white area over the Syrtis shown in Figure 33, and through which the Syrtis itself was faintly visible. This formation he shows on the meridian in Figure 35. The white triangular area in the northern hemisphere of Figure 29 was brilliant. It may have been cloud, since it seems rather too far to the south for an early snowstorm, although its shape suggests the latter. Mr. Phillips does not record it the following night in Figure 10, though he shows a bright area in that vicinity.

Mr. Ellison says that the most remarkable feature of the apparition was the unusual prevalence of great white areas, generally but not always on the planet's limb. He draws several of these, in two cases showing how one of them completely concealed the wider portion of the Syrtis, leaving only the northern tip visible. This is shown also in Mr. Thomson's sketch, Figure 34. The complete concealment of the Syrtis, which was then near the limb, is shown in Figure 26. He speaks of the sharpness of Charontis, which appears to him forked, the prongs facing away from Cerberus. Solis Lacus he represents as a

PLATE XIII

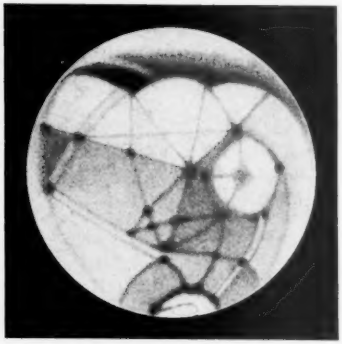


Fig. 13
Maggini 181° D

Fig. 14
Phillips 182° D

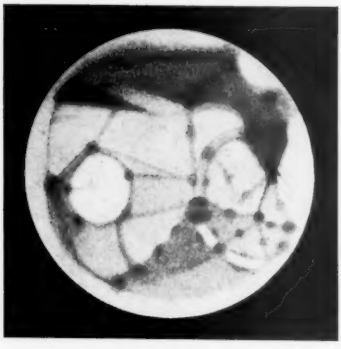


Fig. 17
Maggini 246° E

Fig. 18
Phillips 238° E

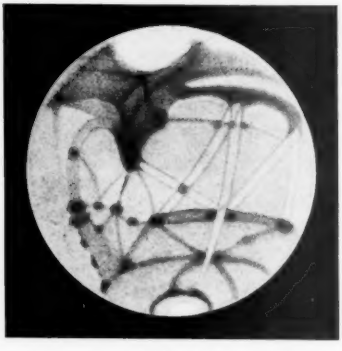


Fig. 21
Maggini 305° F

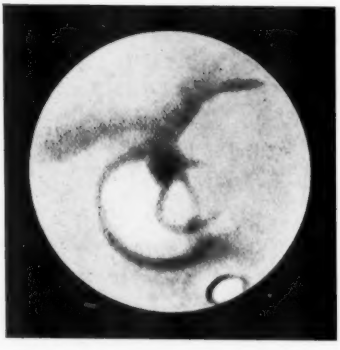


Fig. 22
Phillips 290° F

DRAWINGS OF MARS 1920.

PLATE XIV

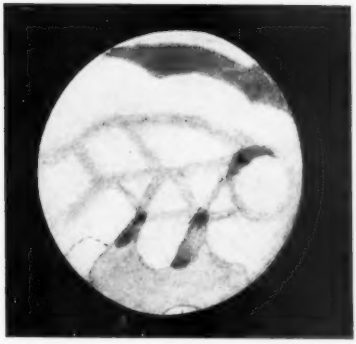


Fig. 15
Pickering 178° D

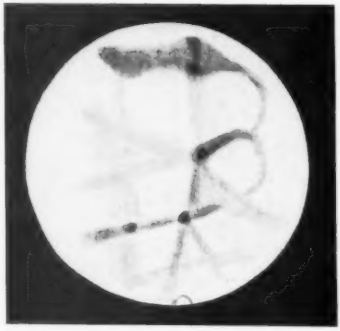


Fig. 16
Douglass 185° D

Fig. 19
Pickering 238° E

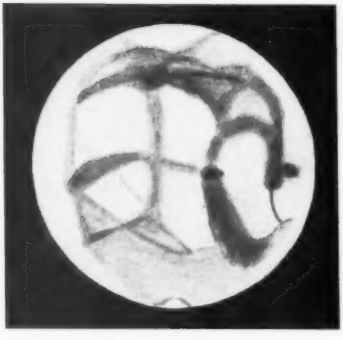


Fig. 20
Douglass 241° E

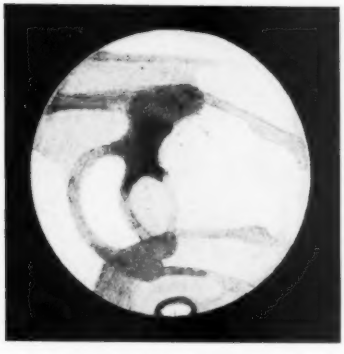


Fig. 23
Pickering 305° F

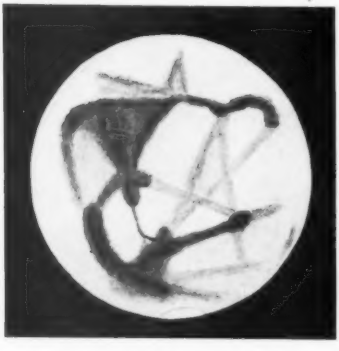


Fig. 24
Douglass 307° F

DRAWINGS OF MARS 1922.

small black point in Figure 28. In general also he sees the canals as extremely narrow sharp lines. In this respect his drawings resemble those of Lowell and Maggini. He uses a lower power than most of the observers (see Table I), and it is possible that this explains in part the difference in the results obtained.

Mr. Buckstaff remarks that the greens, which were predicted for this apparition of the planet, were visible in the maria. This statement is corroborated by the writer and others. He describes some of them as gray green. Acidalium, Casius, and Caloe Palus were a dark gray green. Some of the wider canals he thinks were brownish. Later the maria again turned gray. On May 28 and 29 a white area covered the southern part of the Syrtis and Libya. This was also noted here. He states that is was not visible three days earlier. He refers to the snowstorm that he observed on June 18 and 19. This has been already described, and his drawing given in Report No. **23**.

Mr. Thomson remarks on the several cloud areas shown in his two drawings, Figures 34 and 36, on the gulf shown on the Syrtis at Astusapes, and on the hazy dark line following the limb cloud over Libya. I have often noticed such a line bounding a cloud myself. It presents the appearance of deposited moisture, that is to say of moistened ground, as if due to rain. He makes Hammonis Cornu more pronounced than most of the observers, but I saw it the same way myself at about the same time.

Identification of the Canals.

In the early days of canal discovery, some forty years ago, when even the existence of these objects was doubted by many astronomers, the suggestion was made that they were not really dark streaks drawn on the surface of the planet, but simply the boundary lines between lighter and darker areas. Those who had seen the canals smiled at this idea, as they did at some of the other earlier suggestions offered to explain them, such as that they were water courses, or the grooves ploughed by colliding asteroids.

It now appears however that while the vast majority of the canals are undoubtedly dark and comparatively narrow streaks, yet to some eyes the boundary line between a light region and one only slightly darker does present the appearance of a canal. Thus there can be but little doubt but that what appears to Maggini as a double canal perpendicular to the limb in Figure 5, appears to Douglass in Figure 8 merely as the two sides of a dark band lying between a light and a somewhat darker region. Again this same canal is shown by Maggini in Figure 9, while to the writer and to Douglass it appears again in Figures 11 and 12 as simply the boundaries of a wide dark region. It is of course possible that Maggini's interpretation is the correct one.

A similar effect may be observed by comparing the four central doubles in Figure 1 with the shadings of Figure 3. We have in this

case a very distinct example of the two schools of representation. Figure 3 was drawn with great care with regard to having the shapes, widths, and proportions of the central shaded regions exactly correct. These markings were perfectly sharp and distinct to my eye, and there was not a trace of a narrow canal-like marking visible. The sides were not at all parallel, and our seeing was 11, or practically at its best. Figure 3 was drawn but 9 days later than Figure 1, which latter was also drawn under very favorable conditions, seeing 10. The other four drawings of this region do not give any particular help as to which of these two is the more likely on the face of it to be correct. Figure 4, drawn but four days later than Figure 3, makes the canals of intermediate width, single, and not differing in any respect from numerous other canals which the three observers all agree were narrow and single. The seeing was fair, 7 to 9, and since the three observers all used the same Standard Scale, their recorded seeings are comparable with one another. The separation of the central canals in Figure 1 ranges from 0″.6 to 0″.9, and it is now clear that one of two things is true, either that double canals of this separation affect the writer's eye as faint, uniform, somewhat irregular shaped surfaces, or else that slightly darkened surfaces of this description affect the eyes of the Lowellian school of observers as parallel canals.

The canal Arnon the writer did not see, but each of the other six seen by both Maggini and Hamilton as a double canal appears to the writer simply as a broad rather faintly marked band, the edges being no darker than the middle. Is it then true that the duplication seen by some observers is due simply to contrast between a bright surface and the two edges of a slightly darker moderately wide band? Report No. **5**, **2**. Exactly the same effect is seen clearly by the writer on the moon, where a dark canal or run crosses the snow in a bright craterlet. The contrast in this case is very marked, and the edges of the lunar canal certainly appear darker than the middle, giving the effect of a very clear double. These questionable lunar doubles must not however be confounded with the real clearly marked doubles found in the craters of Aristillus, Eratosthenes, and in a few other places.

Again there is sometimes noted a tendency among the observers to see canals, whose existence is doubtful, in places where one might naturally expect to find them. Thus in Figures 17 and 18 Amenthes is shown going straight south to the Syrtis Minor, whereas in Figures 19 and 20 there is no doubt but that the canal follows the course of Triton, and curves to the left to Cimmerium. The writer made a particular study of this point and could not see Amenthes. It seems very strange that Maggini who could see so many canals, could not see Triton, which was fairly obvious. Again in Figure 21 the region north of the Syrtis does not agree in shape at all with Figures 22, 23, 24, 35, and 36, although it does resemble our standard map (Report No. **15**) more closely than any of the other drawings.

In Table II the canals seen by the different observers are arranged in alphabetical order, the headings of the five following columns give the abbreviations of the observers' names, and the columns themselves give the letters which indicate on which drawings the canals are to be found. These letters are also given in Table I ,and under the drawings themselves. The last column gives the number of observers who saw each of the canals. In some cases no canal is found on our standard map which can be identified with the ones observed. Fortunately Lowell covered the whole surface of the planet with canals so completely, that we can almost always find one that will fit sufficiently well, and we thus do not have to trouble ourselves with finding new names. For this purpose the best maps are contained in his Annals, Vol. III. An index of canals given on page 268 will be found of much assistance. These canals are indicated by the letter L. The canal Marne marked with a P has now been visible at four successive apparitions. A description of it will be found in Report **21**, 7. There are a few cases however, given at the end of our list, where Maggini has succeeded in discovering canals seen neither by Lowell, Jarry-Desloges, nor anybody else. Unless they should in future turn out to be important, it is not considered desirable to increase the enormous number of names, nearly five hundred, with which the planet is already overburdened. Several other canals lie in the dark regions, and are all of them taken from Lowell's maps. Most of them were found by Douglass while he was at the Lowell Observatory, and he is now responsible for putting them on our lists. These canals are indicated by a (*d*), standing for dark region. The eight anonymous canals may be described as follows:

(*a*) Found in Figures 1 and 5, extending from Oxia to Lunae, and probably identical with one detected by the writer, and recorded in Report **21**, as anonymous (*a*).

(*b*) Found in Figure 5, extending from Oxia to Jamuna, south of the previous one, and probably identical with one found by Maggini, also recorded in Report **21**, and there wrongly identified also as anonymous (*a*).

(*c*) Found in Figure 5, extending from Nilokeras I to Issedon, and shown merely as a boundary in Figure 7.

(*d*) Found in Figure 5, but not in Figure 1, north of and nearly parallel to Deuteronilus.

(*e*) Found in Figure 9 just north of Tanais.

(*f*) Found in Figure 13 just north of Boreas.

(*g*) Found by Douglass in Figure 20 north of Libya and to the west of Triton, and curving in the opposite direction.

(*h*) Found in Figure 21 lying parallel to Dosaron and to the west of it.

TABLE II.

CANALS IDENTIFIED IN THE DRAWINGS.

No.	Canals	Mg	Pl	Pk	D	A	Misc.	Obs.
1	Abalos	C						1
2	Aces		C	C	C	C		4
3	Acheron			D	CD	D		3
4	Adonis	D						1
5	Aeolus (*d*) *L*				F			1
6	Aesacus	DE		E	E		E	4
7	Aethiops	D			E			2
8	Agathodaemon	BC	C	BC	BC	BC		5
9	Alander L	BC		B	B			3
10	Alcyonius	E			E			2
11	Amenthes	EF	E			E	E	4
12	Anelon L	B						1
13	Anian	DE			E			2
14	Antaeus	D						1
15	Araxes	C			C			2
16	Arnon	AF			AF			2
17	Asopus				A		F	2
18	Astaboras	AEF	F		AF	F		4
19	Astapus	EF			F			2
20	Astusapes	EF	F	F	E		F	5
21	Aurum (*d*) L				A			1
22	Ausonium (*d*) L				EF			1
23	Baphyras (*d*) L				B			1
24	Boreas	D	E	D	DE			4
25	Boreosyrtis		F	E	E	E		4
26	Borysthenes (*d*) L				B			1
27	Broates		D	D	D			3
28	Cadmus	F			A			2
29	Caleso (*d*) L				F			1
30	Callirrhoe	AF	A	A	AF		B	5
31	Casius	EF	EF	EF	EF	EF	EF	6
32	Casuentus (*d*) L				F			1
33	Cedron	AF						1
34	Cephissus						D	1
35	Ceraunius	BC	C	C	BC		C	5
36	Cerberus	DE	DE	DE	DE	DE	DE	6
37	Chaos	DE	DE	DE	DE		E	5
38	Chrysorrhoas	BC	C	BC	BC	B		5
39	Clarius	C	C	BC	C		C	5
40	Coprates			B	BC			2
41	Cyaneus (*d*)				D			1
42	Cyclops	E		E	D			3
43	Cydnus	D						1
44	Daemon	BC	C	C	BC			4
45	Dardanus			B	A			2
46	Deuteronilus	ABF	A	AF	ABF	A	B	6
47	Djihoun L	A						1
48	Dosaron (*d*) L	F			F			2
49	Dyras (*d*) L				E			1
50	Erebus	D		D	D	D	E	5
51	Erigone		D	D	D			3
52	Erymanthus (*d*) L				E			1
53	Eumenides	CD		C	CD			3
54	Eunostos	DE	DE	DE	DE		E	5
55	Euphrates	AF		A	AF			3
56	Eurotas	CD	C	C	CD			4
57	Fevos	D			D			2
58	Fortuna	BC			BC			2
59	Galaesus (*d*) L	E			D			2

TABLE II.—CONTINUED.

No.	Canals	Mg	Pl	Pk	D	A	Misc.	Obs.
60	Galaxias	DE			E			2
61	Ganges	BC			B	B	C	4
62	Gehon	AF		A	A	A		4
63	Gigas	D	C	CD	BC			4
64	Gorgon					C		1
65	Gyndes	D	E	E	D	D	DE	6
66	Hades	D	D	D	DE	D	D	6
67	Hebe			B	B			2
68	Hebrus	C						1
69	Heliconius	DE	E	E	E	E	E	6
70	Hephaestus	E			E		E	3
71	Hiddekel	AF						1
72	Hippalus	C		C				2
73	Hippus (*d*) L	F						1
74	Hyblaeus	DE	DE	DE	DE		E	5
75	Hylias (*d*) L				F			1
76	Hypanis (*d*) L				B			1
77	Hyperboreas	BDF	ABF	BEF	BC	E	DE	6
78	Ilissus			C	C			2
79	Indus	AB				A		2
80	Iris	C						1
81	Isiacum L	EF						1
82	Issedon	B						1
83	Jamuna	AB			AB	B		3
84	Japhyx L				D			1
85	Kison	AF			A			2
86	Laestrigon	DE			DE			2
87	Laus (*d*) L				E			1
88	Limyrus L	DE						1
89	Lophis L	E						1
90	Lycus	C						1
91	Marne P	D		D				2
92	Mascas L	E						1
93	Nar L	E						1
94	Nasamon	EF						1
95	Nectar	BC		BC	B			3
96	Nepenthes	EF	EF	EF	EF	EF	EF	6
97	Nilokeras	B	B	B	B	B	AB	6
98	Nilokeras I L	ABC	C	B	BC	B		5
99	Nilosyrtis	EF	F	AEF	AEF	EF	F	6
100	Nilus					BC	C	2
101	Orcus	D	D	D	D			4
102	Orontes	F			A			2
103	Orosines (*d*) L	F			F			2
104	Oxus			A	AB		A	3
105	Pactolus	E				E		2
106	Phison	AF		A	F			3
107	Phlegethon			B	C		C	3
108	Pierius	AF		AF	AF		F	4
109	Protonilus	AF	AF	AF	AF	F	F	6
110	Pyramus	F			A			2
111	Pyriphlegethon	CD		D		D		3
112	Python	AF		F				2
113	Rhymmus (*d*) L				B			1
114	Rhyndacus	D			D			2
115	Sirenius	D		C		C	C	4
116	Siris	A			A			2
117	Sitacus		A	A	F	A	A	5
118	Steropes L	B						1
119	Styx	DE	DE	DE	DE	DE	E	6

TABLE II.—CONTINUED.

No.	Canals	Mg	Pl	Pk	D	A	Misc.	Obs.
120	Subus L	EF						1
121	Tanais	BC		C	ABC		C	4
122	Tantalus			D				1
123	Tartarus	D						1
124	Thestor (*d*) L				B			1
125	Thoth	EF	EF	EF	EF	EF	EF	6
126	Titan	CD						1
127	Triton			E	EF			2
128	Typhonius	F						1
129	Ulysses	C						1
130	Uranius	BC	C	CD	B			4
131	Xenius	AF						1
132	Anonymous (*a*)	AB						1
133	" (*b*)	B						1
134	" (*c*)	B						1
135	" (*d*)	B						1
136	" (*e*)	C						1
137	" (*f*)	D						1
138	" (*g*)				E			1
139	" (*h*)	F						1

STATISTICS OF THE CANALS.

Information regarding the number of canals recorded by each observer is contained in Table III. When a canal was seen by all six observers we may describe its visibility as 6. When seen by only five observers its visibility is 5, and so on. The first column of the table records the visibility, and the next six give the number of canals of each of these visibilities seen by each observer. The last column gives the total number of canals of each degree of visibility. The next to last horizontal row of figures gives the total number of canals seen by each observer, and the last row the number of his canals that were confirmed by at least one other person. Thus Professor Douglass saw 6 more confirmed canals than any other observer, and what is remarkable is that of his 17 unconfirmed canals 15 were in the dark regions of the planet, so that he had only 2 unconfirmed canals in the bright regions. Some 19 in all of these dark region canals were observed, 18 by Douglass and 4 by Maggini. Only 3 therefore were seen in common. Douglass is very certain that they exist, but few other observers can see them.

These dark region canals form a class by themselves, and are really another kind of phenomenon. Therefore leaving them out of consideration, Professor Douglass's result of recording 77 confirmed canals, with only 2 that were unconfirmed, establishes a record as far as our experience goes. Of course it could not have been done without Dr. Maggini's very efficient aid as a "runner up." Especial stress is laid on the small number of canals unconfirmed, which is the only thing which makes the record remarkable. The number of confirmed canals on each of his drawings was on A 19, B 19, C 18, D 20, E 22, F 17, average 19. They seem to have been very uniformly distributed in

longitude. These numbers are interesting as showing how many canals we should expect to find on any one drawing made under really favorable conditions. It will be noted that the observations were all secured with an 8-inch Clark refractor. All the other observers used, or had access to, instruments of larger aperture. See list of Observers.

TABLE III.

THE NUMBER OF CANALS RECORDED.

Obs.	Mg	Pl	Pk	D	A	Misc.	Total
6	13	13	13	13	13	13	13
5	11	11	12	12	5	9	12
4	14	10	13	14	8	7	16
3	9	2	12	13	3	3	14
2	24	0	8	25	2	1	31
1	33	0	1	17	1	1	53
Total	104	36	59	94	32	34	139
Confirmed	71	36	58	77	31	33	86

It will be noticed that Phillips, Attkins, and the miscellaneous observers all saw about the same number of canals, and that their observations were generally confirmed by others. The fact that they saw far fewer canals than the other three was undoubtedly due to the circumstance that the planet was to the south of the equator, which while it helped the Australian, interfered with all the other observers. The three observers who saw the largest number of canals saw 40 in common, or more than half the number of confirmed canals seen by any of them.

It should be pointed out here that the work of the miscellaneous observers is considered to be of very considerable importance. Not only do their drawings, if they are skillful draftsmen, confirm or distinguish between the shapes of the various details as shown by the other observers, who are more fortunately situated, but the mere fact that they cannot see so many canals enables us to classify these objects with regard to their visibility. To record one hundred canals is not of much consequence by itself, but if we can group them so as to say at this season of the planet's year these twenty canals were most conspicuous, those twenty next, and so on, then we have accomplished something worth doing. From this point of view the miscellaneous observers may consider themselves quite as important as any of the others, because they are helping us to do something that could not well be done without their aid.

Of the 30 canals taken from Lowell's maps, 5 were seen by two or more observers. These were Alander, Dosaron, Galaesus, Nilokeras I, and Orosines. Nilokeras I was very prominent this year. It was seen by 5 observers, but was not recorded at all during the three previous apparitions. Alander was seen by three observers. In 1914 the total number of confirmed canals numbered 45, in 1916 54, in 1918 83, and the present apparition 86, showing as was expected that we had now about reached the maximum number.

TABLE IV.

PROPORTION OF THE CANALS VISIBLE TO THE DIFFERENT OBSERVERS.

Visible	Mg	Pl	Pk	D	A	Misc.	Total
6	1.00	1.00	1.00	1.00	1.00	1.00	13
5	.92	.92	1.00	1.00	.42	.75	12
4	.88	.62	.81	.88	.50	.44	16
3	.64	.14	.86	.93	.21	.21	14
2	.77	.00	.26	.81	.07	.03	31
1	.62	.00	.02	.32	.02	.02	53
Confirmed	.83	.42	.68	.90	.36	.38	1.00

In Table IV the arrangement is similar to that in Table III, except that instead of giving the total number of canals seen by each observer, it gives the proportion of the total number recorded. These total numbers are given in the last column of Table IV, and are taken directly from Table III. As we descend the columns to fainter and fainter canals, the proportion of the total number seen by each observer should gradually decrease, falling off sharply when he approaches his limit, and this we find in general to be the case. Thus Pickering and Douglass both saw all of the 25 most conspicuous canals. The number holds well for the former until we get down to visibility 2, when he saw only one-quarter of the canals of this grade. This therefore establishes his limit. Douglass goes one step further. The last horizontal line of the table shows the proportion of confirmed canals that each observer contributed to the final result. It is deduced from the last horizontal row of Table III.

TABLE V.

LAKES IDENTIFIED IN THE DRAWINGS.

No.	Lakes	Mg	Pl	Pk	D	A	Misc.	Obs.
1	Acidalius L				B			1
2	Ammonium	D						1
3	Arethusa	AF		AF				2
4	Arsenius	D	D	D		D	D	5
5	Ascraeus	BC			C			2
6	Aspledon L	C						1
7	Caesia L	D						1
8	Caloe	AEF	F	AF	F	E	F	6
9	Cassotis L	DE						1
10	Castorius	C	D	D	D			4
11	Copais	F						1
12	Cranium L	A						1
13	Cyane L		C			C	C	3
14	Gomer L				E			1
15	Gordii	CD						1
16	Hecatis	DE						1
17	Hipponis L	EF						1
18	Hipponitis L II	AF						1
19	Hyperboreas	ABC	AB	B	B			4
20	Isidis L II	F						1
21	Ismenius	AF		AF	AF	A	F	5
22	Jovis L	C						1
23	Juventae			B				1
24	Laestrygonis L				D			1

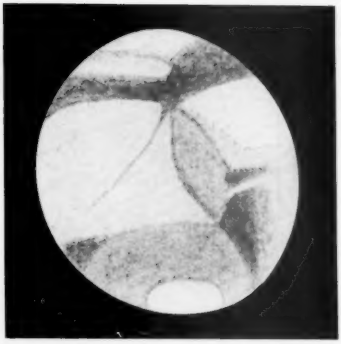


Fig. 25
Attkins 4° A

Fig. 26
Ellison 356° A

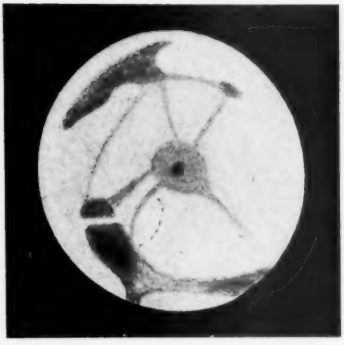


Fig. 27
Attkins 71° B

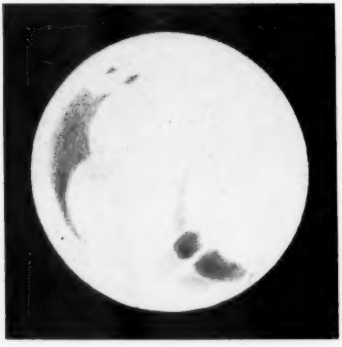


Fig. 28
Ellison 63° B

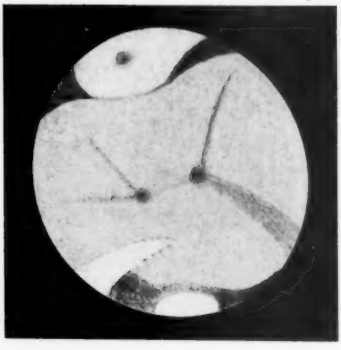


Fig. 29
Attkins 117° C

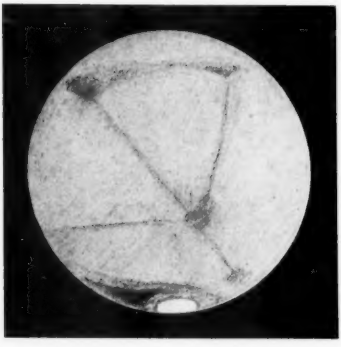


Fig. 30
Buckstaff 111° C

DRAWINGS OF MARS 1922.

PLATE XVI

Fig. 31
Attkins 169° D

Fig. 32
Brindley 200° D

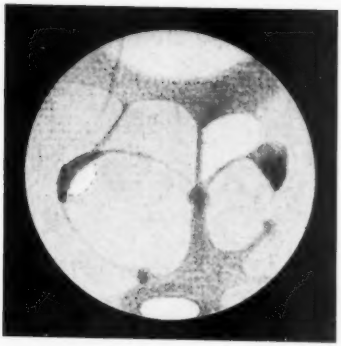


Fig. 33
Atkins 248° E

Fig. 34
Thomson 232° E

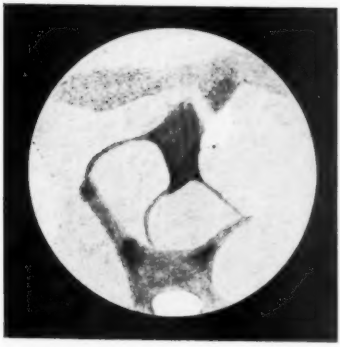


Fig. 35
Attkins 288° F

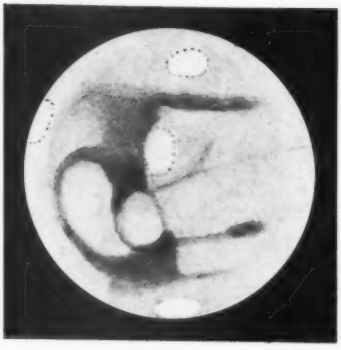


Fig. 36
Thomson 305° F

DRAWINGS OF MARS 1922

TABLE V—Continued.

No.	Lakes	Mg	Pl	Pk	D	A	Misc.	Obs.
25	Lucrinus L	DE						1
26	Lunae	ABC	C	B	B	B		5
27	Maeisia L	B			B			2
28	Maeotis	C						1
29	Maricae L	C						1
30	Messeis L	BC	B	B	BC	B	B	6
31	Moeris	E						1
32	Molorchi L	E						1
33	Moreh L	D						1
34	Morpheos L	DE					E	2
35	Nectaris	C						1
36	Niliacus	B	AB	AB	AB	AB	B	6
37	Nilus L	E						1
38	Novem Viae L	A			A			2
39	Nuba	EF	E			EF	E	4
40	Olympia L				A			1
41	Ortygia L	D						1
42	Oxia	AB		A				2
43	Panopis L					C		1
44	Phoenicis	CD		C				2
45	Propontis I	D	D	D	D	D	D	6
46	Propontis II	D						1
47	Pseboas L	E						1
48	Scotitas L	DE						1
49	Secundus L	DE		D	DE	D	E	5
50	Semnon L	D						1
51	Siloe	ABF						1
52	Sirbonis	F						1
53	Sithonius	DE				E		2
54	Solis	BC	C	B	BC	C	B	6
55	Stymphalius	DE						1
56	Tertius L	DE						1
57	Thymbra L	D						1
58	Tithonius	BC			BC			2
59	Triton	EF			E			2
60	Anonymous (*a*)	AB						1
61	" (*b*)	B						1
62	" (*c*)	B						1
63	" (*d*)	B						1
64	" (*e*)	B						1
65	" (*f*)						E	1

TABLE VI.

THE NUMBER OF LAKES RECORDED.

Obs.	Mg	Pl	Pk	D	A	Misc.	Total
6	5	5	5	5	5	5	5
5	4	2	4	3	4	3	4
4	3	3	2	2	1	1	3
3	0	1	0	0	1	1	1
2	10	0	3	5	1	1	10
1	35	0	1	4	1	1	42
Total	57	11	15	19	13	12	65
Confirmed	22	11	14	15	12	11	23

IDENTIFICATION AND STATISTICS OF THE LAKES.

In Table V is given a list of the various lakes identified in 1920 upon the planet. Maggini saw about 50 anonymous lakes, either single ones that had not been seen before, or duplications of lakes that had already

been named. Only 5 of these are included in Table V however, together with one seen by Thomson on the Hyperboreas canal that was not seen by anyone else. He describes it as well marked. It was probably very short lived, being doubtless due to a local thaw. Of the 5 seen by Maggini (*a*) is located on Jamuna, and is shown in both Figures 1 and 5. The other four are all shown in Figure 5. (*b*) is located on Jamuna to the south of (*a*), and is double. (*c*) is double,

TABLE VII.

PROPORTION OF THE LAKES VISIBLE TO THE DIFFERENT OBSERVERS.

Visible	Mg	Pl	Pk	D	A	Misc.	Total
6	1.00	1.00	1.00	1.00	1.00	1.00	5
5	1.00	.50	1.00	.75	1.00	.75	4
4	1.00	1.00	.67	.67	.33	.33	3
3	.00	1.00	.00	.00	.50	.50	2
2	1.00	.00	.33	.50	.11	.11	9
1	.83	.00	.02	.10	.02	.02	42
Confirmed	.96	.48	.61	.65	.52	.48	1.00

and follows Ascraeus on Gigas. (*d*) and (*e*) are single and are located to the south of Ascraeus and anonymous (*c*). Tables VI and VII are arranged precisely like Tables III and IV, and the same remarks in general apply to them. The number of confirmed lakes in 1914 numbered only 8. In 1916 it was 12, in 1918, 26; and in 1920, 23.

Mandeville, Jamaica, B. W. I.
December 22, 1922.

THE DIAMETER OF STARS FROM RADIOMETRIC MEASURES.

By HARLAN TRUE STETSON.

One of the most important and at the same time spectacular advances in observational astronomy has come with the recent application of the interference method to the measurement of star diameters. To the uninitiated, the measurement of the actual diameter of a star so remote that no size or shape may be discerned in the most powerful telescope seems all but incredible. To scientific workers who are ever accustomed to new applications of physical methods and physical apparatus, the interference experiments of Michelson so admirably carried out by Anderson and Pease at Mount Wilson have been heralded not only as remarkable achievements in manipulation, but as fruitful of results of utmost importance to check astrophysical theories. The rapid development of the newer theories of stellar evolution, the

correlation of luminosities or absolute magnitude with spectral type, and the resulting division of stars into dwarfs, giants and supergiants, call for new data and new checks on hypothetical conditions. The fact that the diameter of Betelgeuse, the first star whose diameter was measured, came so near the value predicted by Eddington from astrophysical considerations was reassuring to the astrophysicist. From a consideration of relative surface brightness and color index, Russell has shown[1] it possible to predict the probable angular diameter of any star of known spectral class and visual magnitude, and hence the actual linear diameter if the star's distance is known. From such considerations the predicted angular diameters of Betelgeuse, Antares, and Arcturus have been given as 0".031, 0".028, and 0".019 respectively.

Hardly less important than the interferometer method of measuring stellar diameters has been the rapid progress which has been made in the development of radiometric apparatus capable of making quantitative measurements of the total radiation from the stars. From the earliest attempts of Huggins[2] and Stone[3] to the novel application of the radiometer by Nichols[4] to the detection of radiation from Arcturus at the Yerkes Observatory in 1900, progress was slow. With the rapid improvements in thermo-elements and their use in evacuated receptacles by Pfund and especially by Coblentz, quantitative measurements of stellar radiation have now become possible. With apparatus at least 150 times as sensitive as that of Nichols, Coblentz measured in 1914 at the Lick Observatory[5] the radiation of 110 stars giving quantitative data on stars to the fourth magnitude; and there has recently appeared an additional list of 16 stars measured by Coblentz at the Lowell Observatory.[6] Using the 100-inch mirror at Mount Wilson, Abbot, Pettit and Nicholson have already, after preliminary experiments, obtained data for the radiation of 13 stars.[7]

It was from an examination of the data of the 110 stars furnished by Coblentz that the possibility of obtaining very simply an independent idea of their diameter from the radiometric measures became apparent. If we make certain bold assumptions, e. g., that the stars radiate as black bodies, and that the thermopile measures their total radiation, we may readily show how an expression for the angular diameter of a star whose total radiation has been measured may be obtained. Although the result will be somewhat inexact, for reasons already noted, nevertheless it should be sufficiently approximate to be of interest astrophysically and may serve as another independent method of assuring ourselves of the order of magnitude of stellar diameters.

In all thermo-electric measures of radiation, we consider a well designed thermopile as non-selective, and that the current generated and hence the galvanometer deflection (within the limits of the instrument) will be proportional to the energy falling upon the receiving

surface. In the case of the outfit No. 7 used at Mt. Hamilton, Coblentz found 1 mm deflection of the galvanometer corresponded to the amount of energy of 34×10^{-14} gram calories falling on each square centimeter of the mirror per minute. From the work of Abbot, the most probable value of the radiation received from the sun transmitted through the atmosphere would appear to be about 1.5 gram calories per cm^2 per minute. If for the sake of comparison we suppose the sun to be removed to the standard distance of ten parsecs (the distance at which a star's absolute magnitude is the same as its apparent magnitude), then it can be readily seen that the radiation emitted by the sun at the distance of 10 parsecs E_1 will be related to its present radiation E_2 in the manner

$$\frac{E_1}{E_2} = \frac{1^2}{2{,}062{,}650^2}$$

or since $E_2 = 1.5$ (the solar constant) we have

$$E_1 = 23.5 \times 10^{-14} \times 1.5 = 35.2 \times 10^{-14}$$

Now, since 1 mm deflection $= 34 \times 10^{-14}$ gram calories, we see that the galvanometer deflection which would be produced with Coblentz's apparatus by the sun at a distance of 10 parsecs is

$$35.2 \times 10^{-14}/34 \times 10^{-14} \text{ or } = 1.03.$$

Further, if d represents the galvanometer deflection in mm for any star whose distance is D parsecs, then the deflection d_0 which would result if the star were at the standard distance of 10 parsecs may be written

$$d_0 = d(D/10)^2$$

or if we introduce the star's parallax p in place of parsecs for distance, we have, since $D = 1/p$

$$d_0 = d/100\,p^2.$$

Again, since radiating power is proportional to galvanometer deflections for objects at the same distance, we have for the complete radiation received from a star as compared with the sun the relation

$$R = d/1.03 \times 100\,p^2 = .0097\,d/p^2 \qquad (1)$$

where $R =$ radiation of star in terms of the sun, $d =$ observed galvanometer deflection in mm, and p is the star's parallax in seconds of arc.

The amount of radiation received from a star at a given distance will depend upon (1) the emissive power per unit area which is a function of the star's temperature, and (2) the area of the surface presented to the earth. If e_1 and $e_2 =$ emission per unit area for a star and the sun respectively, and r_1 and $r_2 =$ the corresponding radii

(neglecting absorption at the limb), then the radiation received from a star, as compared with the sun, is

$$R = e_1 r_1^2 / e_2 r_2^2$$

Now, from Stefan's law of radiation we know that

$$e_1/e_2 = T_1^4/T_2^4,$$

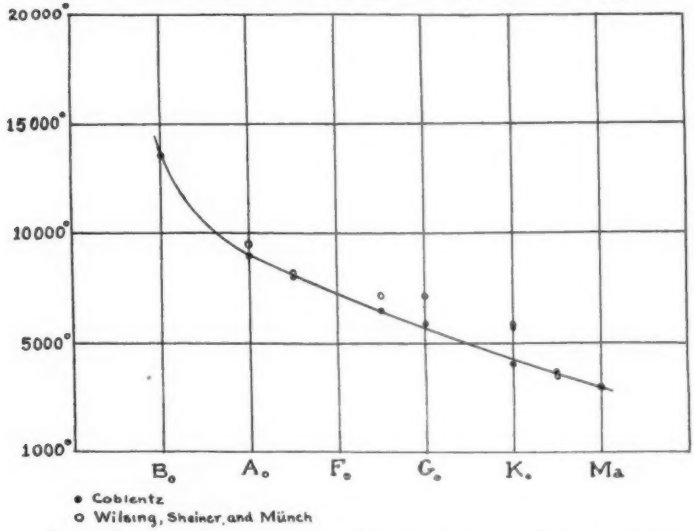
where T_1 and T_2 are the absolute temperatures of the star and sun respectively. Therefore another expression for R takes the form

$$R = T_1^4 r_1^2 / T_2^4 r_2^2 \qquad (2)$$

If we adopt for T_2 the mean temperature of the sun as 6000° (which is in accord with the latest published values of Abbot and Fowle[8]) and let r be the star's radius in terms of that of the sun, we have, by combining (1) and (2) and solving for r,

$$r = 6000^2 \times \sqrt{(.0097\, d)} / T^2 p \qquad (3)$$

From the distribution and displacement laws, the temperature of a star may be determined from the spectrum; and the approximate



Curve Showing Correlation of Temperature with Spectral Types.

temperatures of stars of given spectral types have become well known through the work of Wilsing, Scheiner and Münch.[9] The investigation of the spectral energy curve of 16 stars by Coblentz[10] through the use of absorbing screens has furnished additional and important data on the relation of stellar temperatures and spectral types. Taking the means of the published values, the accompanying curve shows the

relation between spectral type and absolute temperature for the latest results of Coblentz. The earlier values of the Potsdam observers are shown for comparison.

From a knowledge of the spectral type, T becomes approximately known in equation (3), and we may at once calculate the radius of any star whose parallax is known; or, taking the sun's radius as 0.00467 astronomical units, we may express the apparent angular diameter of a star in seconds of arc thus:

$$D'' = 2rp = 2(6000/T)^2 \times .0988 \times 0.00467 \sqrt{(d)} = 0.00092\,(6000/T)^2 \sqrt{(d)},$$

which is in a convenient form for computation.

Using this formula, the angular diameters of Betelgeuse, Antares, and Arcturus are found to be in remarkably close agreement with the values determined with the interferometer at Mount Wilson, as shown in the accompanying table, which also gives for comparison the hypothetical diameters predicted by Russell, by Wilsing, and by Eddington.

	Computed from Coblentz's Data		Mt.Wilson Measures	Predicted Diameters		
	(1914)	(1921)		Russell	Wilsing	Eddington
Betelgeuse	0".047	0".043	0".047	0".031	0".039	0".051
Antares	.037	.034	.040	.028		.043
Arcturus	.018	.018	.022	.019	.031	.020

It is hardly to be expected that the results compared in columns one and two should agree better than within ten per cent. The uncertainty in our value for the solar constant (1.5), as measured through the earth's atmosphere, the absolute temperatures of the individual stars taken from the curve of absolute temperatures and spectral type, to say nothing of the accidental errors of the observed value, would certainly subject the results to an uncertainty of this amount. The remarkable thing is that, although stars are not true black bodies, they radiate as nearly like black bodies as they do. The significant fact, that the computed values based on Coblentz's work show better agreement with the diameters measured at Mount Wilson, is probably due to the fact that the thermopile data are based far more nearly on the complete radiation spectrum than are the data used by Russell or by Wilsing, which are based on visual or photographic spectral data.

Coblentz has shown special interest in the wide difference in radiation of stars of the same apparent magnitude but of contrasting spectral types, showing that red stars emit on the average three to four times as much total radiation as the blue stars of much higher temperature. The reason, surprising as it might at first seem, becomes at once apparent on the grounds of modern ideas of stellar evolution, for the giant M stars such as Betelgeuse must have many times the surface area of the smaller, though hotter, A type stars such as Sirius. Any red stars in the dwarf stage are undoubtedly too feeble

in radiating power to be measured with a thermopile, and of course would not be included.

Below is appended a table giving the computed apparent diameters of a number of stars selected from Coblentz's list. The last column gives the diameters predicted by Hertzsprung,[11] based on a formula arbitrarily corrected by the Mount Wilson measure of Betelgeuse. The approximate linear diameter in millions of miles is given on the basis of the parallaxes listed, which are the means in most cases of several determinations.

TABLE.

Star	Type	Parallax	Approx. Diam.	Approx. Diam. in Miles	Diam. Predicted by Hertzsprung
α Orionis	Ma	0".018	0".047	242,000,000	0".042
α Scorpii	Map	0.009	0.037	382,000,000	.....
α Herculis	Mp	0.015	0.030	185,800,000	0.013
β Pegasi	Mb	0.035	0.028	74,400,000	0.018
α Tauri	K5	0.062	0.021	32,000,000	0.035
α Boötis	K0	0.095	0.017	17,000,000	0.025
β Androm.	Ma	0.060	0.017	23,000,000	0.016
β Geminorum	K	0.06	0.009	14,000,000	0.013
α Aurigae	G	0.078	0.007	8,360,000	0.011
α Ursae Min.	F8	0.08	0.007	8,170,000	0.004
γ Androm.	Kp	0.004	0.007	163,000,000	.....
β Ophiuchi	K0	0.023	0.005	20,200,000	0.007
α Canis Maj.	A0	0.367	0.004	1,030,000	.....
α Arietis	K2	0.037	0.004	10,000,000	0.010
ε Geminorum	G5	0.007	0.003	40,000,000	0.009
α Persei	F5	0.03	0.002	9,000,000	0.004
γ Serpentis	F8	0.075	0.002	2,400,000	0.002
α Leonis	B8	0.03	0.001	3,000,000	0.002

From an examination of the table, it would appear that three stars, α Herculis, β Pegasi, and α Tauri, might present apparent diameters in excess of that of Arcturus, whose diameter is the smallest of the three measures thus far published from the Mount Wilson Observatory.

Acknowledgement is due Dr. Coblentz for unpublished information making possible a direct comparison between his radiometric measures made at the Lowell Observatory in 1921 with those made at the Lick Observatory in 1914. If such a comparison is made, there is remarkably satisfactory agreement, with discrepancies less than 10 per cent in almost every instance. As no correction has been made for differences in atmospheric absorption, this is all that could be expected. In the case of α Orionis, however, which is known to be variable, we find in the 1921 measures 15.00 cm galvanometer deflection corresponding to 19.14 cm deflection in 1914. This star is of course known to be variable. It is interesting to speculate, however, whether the variation in radiation in the 1921 measurement is due chiefly to a possible change in diameter or a change in the star's temperature. The idea of a changing diameter has already been suggested by Pease,[12] from experiments with the interferometer. A series of diameter determinations, together with a careful watching of the spectrum, should be

able to throw light on the causes of variability. What is true of α Orionis is accentuated further in the case of α Herculis, where Coblentz has noted a change of more than 40 per cent in the star's radiation in a single night.

Harvard University, Astronomical Laboratory.

[1] POPULAR ASTRONOMY, 29 : p. 30; 1921.
[2] Huggins, Proc. Roy. Soc. 17 : p. 309; 1868-69.
[3] Stone, Proc. Roy. Soc. 18 : p. 159; 1869-70.
[4] Nichols, Astroph. J. 13 : p. 101; 1901.
[5] Coblentz, Lick O. Bulletin. 8 : p. 104; 1915.
[6] Coblentz. Astroph. J. 55 : p. 20; 1922.
[7] Pub. Astron. Soc. of the Pacific. 34 : p. 182; June, 1922.
[8] Abbot and Fowle, Jour. Opt. Soc. Am. **5**, p. 272, 1921.
[9] Wilsing, Scheiner and Münch, Pub. Astro. Obs. Potsdam **24**, No. 74, 1920.
[10] Coblentz, Scientific Papers of Bureau of Standards No. 438, p. 739, 1922.
[11] Annalen Van De Sterrewacht Te Leiden, Deel XIV, Eerste Stuk, 1922.
[12] Pub. of the Astron. Soc. of the Pacific, 34 : 183.

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(Continued from page 195.)

THE PARALLAX OF B. D. 39°4694, USING TWO SETS OF COMPARISON STARS.

BY LAURA E. HILL.

The field B. D. 39°4694 is rich in stars. Two sets of comparison stars of four each were used for the determination of the parallax. The inner set are of mean magnitude 9.2 and at an average distance from the parallax star of 347″; the mean magnitude of the distant stars is 9.0 and they are at an average distance of 1288″. In neither set did the individual stars differ greatly from the mean magnitude and the mean distance. Sixteen plates from seven epochs give the following results:

	Relative Parallax	Relative Proper Motion in R. A.
Near Comparison Stars	+0″.059 ± 0″.008	+0″.414 ± 0″.007
Distant Comparison Stars	+0.068 ± 0.009	+0.429 ± 0.008

The two sets of comparison stars, radically different in distribution, are seen to give quite accordant results.

THE SPECTRUM OF o CETI AT MINIMUM.

By Alfred H. Joy.

Attention has been called in several notes (Adams and Joy, *Publications Astronomical Society of the Pacific*, **29**, 112, 1917; **30**, 193, 1918; **32**, 163, 1920; **33**, 107, 1921) to the remarkable changes in the spectrum of o Ceti at different phases of its light fluctuation. The use of the 100-inch telescope has made it possible to follow these changes throughout the whole of the minimum of light. The spectral variations have been found to repeat themselves very closely year after year during the past seven years since observations were begun at Mount Wilson and apparently they depend largely on magnitude rather than phase measured from maximum.

When the star reaches the minimum phase the appearance of the spectrum is quite changed from its earlier aspects. The continuous spectrum is relatively stronger in the violet, especially in the region near Hδ. The absorption lines, with the exception of a few of the strongest, have completely vanished. The titanium oxide bands are strengthened and seem to extend as far as Hδ. The sharp bright lines of hydrogen have disappeared but some of the bright low temperature lines of other elements are still visible although faint.

The most striking feature of the spectrum at this phase is, however, the gradual appearance of a hydrogen and helium spectrum whose bright bands are more prominent with respect to the continuous spectrum than the well-known sharp, bright hydrogen lines at maximum. These broad hydrogen bands are made up of two components separated by a strong absorption line, the red component being much stronger than the violet so that the weaker plates show only the component displaced to the red. Both shade off from the absorption line making measures difficult and unreliable.

The total width of the band is about 10 angstroms, the red component being displaced about 3 angstroms and the violet component about the same amount toward the violet from the normal position of the hydrogen lines. The absorption line, however, is not symmetrically placed but falls to the violet side of the center by about one angstrom. The bands decrease in intensity from red to violet and Hβ is the first to appear. This form of emission is not uncommon for hydrogen lines of early type stars. The helium line λ4471 is certainly present as a bright line and other helium lines are suspected. They are very diffuse but do not seem to have an absorption line superposed upon them and their position is normal.

In connection with these peculiar bright lines there is apparently some weak continuous spectrum of an earlier type than the Md spectrum. Both bright bands and continuous spectrum are displaced along the slit, giving the remarkable unsymmetrical aspect seen in the spectra taken at minimum. In the region of the stronger bands the

asymmetry is most prominent, resulting in a decided "sawtooth" effect. Rotation of the spectrograph shows that the effect is smallest when the position angle of the slit is 45° and greatest at 135°. The normal east-west position of the slit gives an intermediate value. The displacement measured corresponds to a distance of 0".3 between the sources of the two spectra, the source of the usual Md spectrum being to the NW of the other.

It may be possible to explain the observed phenomena by supposing changes in the relative position as seen from the earth of an enveloping shell of gas with respect to underlying layers of atmosphere, produced either by actual translation or by rotation of a single body. In some ways it would be simpler to consider two separate bodies, one a variable of the usual long period type with spectrum changing from M6e to M9e and the other a very faint star having an early type spectrum with strong emission bands of hydrogen and helium. In this case, however, the companion should be visible to double star observers. Professor Barnard kindly examined the star at minimum last year but did not find any evidence of a second component.

SERIES AND OTHER REGULARITIES IN THE ARC SPECTRA OF CHROMIUM AND MOLYBDENUM.

By C. C. Kiess.

The arranging of the lines of a spectrum into series has been confined almost entirely to the elements of the first three or four columns of the periodic classification. The many-lined spectra of the remaining elements have as yet been unravelled except for the detection in them of unrelated constant frequency differences. For more than a year the arc spectrum of chromium, and more recently that of molybdenum, have been under investigation to detect series and other regularities that may occur in them. A recent note to *Science* (**56**, 666, 1922) describes the types of series that have been found in the spectrum of chromium —namely two parallel sets of series of wide triplets, and one of narrow triplets. In the spectrum of molybdenum also occur three series systems of triplets—two parallel systems of widely separated triplets and one system of narrow triplets. Recent work on manganese by Catalan, (*Philosophical Transactions*, A, **223**, 146, 1922) has revealed a new type of regularity in spectra to which he has applied the name multiplet. These consist of groups of 9, 12, and 15 lines related by constant frequency differences, some of which are the same as those occurring in the series triplets. Catalan has published three multiplets belonging to chromium. Our work has revealed the existence of several more multiplets belonging to chromium and of several belonging to molybdenum. In fact, the first triplet of the parallel principal series

of molybdenum is probably a part of a multiplet. Since more lines of the spectrum belong to multiplets than to the series of ordinary types, the idea is suggested that the multiplet is the general type of regularity of which the series members are special types.

ON THE ACCURACY WITH WHICH PARALLAXES CAN BE DETERMINED FROM SPECTRAL CLASS AND PROPER MOTION.

By Knut Lundmark and Willem J. Luyten.

The recent progress in measuring stellar parallaxes together with the present accuracy in spectral classification has resulted in establishing a fairly definite relationship between the absolute magnitude of a star and its spectral class. For a given spectral class there seem to exist certain maxima of frequency around which the absolute magnitudes crowd with rather small dispersion. A discussion of the parallaxes and spectral classes of about 1500 stars indicates that this dispersion can in large measure be attributed to errors in the spectral classification and in the measured parallaxes. If we now assume a constant absolute magnitude for given spectral class we can use the spectral class for computing parallaxes.

Furthermore it has been shown that the proper motion of a star, reduced to a common magnitude, is for a given spectral class closely related to the absolute magnitude. From a knowledge of the reduced proper motion it is thus possible to obtain a reliable prediction of the parallax. Provisional data for the performing of this computation have been given in *Lick Observatory Bulletin*, **10**, 135, 1922 and *Publications Astronomical Society of the Pacific*, **34**, 156 and 342, 1922.

Apart from its application in this direction, the reduced proper motion also furnishes a clue for discriminating between giants and dwarfs. It can thus be very useful in connection with the first method. Besides, we can use as criteria for the discrimination between giants and dwarfs, the behavior of certain absorption lines in the spectrum, the color, and the radial velocity. The reduced proper motion however, can be regarded as the principal criterion.

It is thought that a combination of the two methods will give a still better prediction of the parallax.

As a test of the accuracy of this combination, we have compared our parallaxes of 35 double stars, having large proper motion, with the corresponding trigonometric and spectroscopic values. This material has been selected for various reasons, viz.:

1. The distance and therefore the parallax of the two components is necessarily the same, thus putting the parallaxes of the two components to another test.

2. The large proper motion of these stars makes plausible an absolute magnitude below the mean for their spectral class, in view of the well-known progressive change in space velocity with absolute magnitude. The spectral parallax is therefore liable to be too small. At the same time the very large proper motions make it doubtful whether the relation between reduced proper motion and absolute magnitude follows the formulae derived from the mean of a large number of stars.

3. Among these stars occur many red dwarfs. A small error in spectral classification will accordingly introduce a larger error in absolute magnitude, as the quotient $\Delta M / \Delta S$ is very large here.

We see from the foregoing that the conditions are rather unfavorable for our methods, as we can expect both large systematic and accidental errors. The test may therefore be regarded as very severe.

Before stating the results we shall adopt the following notations:

M_S = absolute magnitude computed from spectral class.

M_H = absolute magnitude computed from reduced proper motion.

M_{SH} = mean of the two previous quantities.

M_{tr} = absolute magnitude derived from trigonometric parallaxes.

M_{sp} = spectroscopic absolute magnitude.

A bar denotes mean values.

We then find:

$$\overline{M}_S - \overline{M}_H = -0^M.08$$

$$\overline{M}_{tr} - \overline{M}_{SH} = +0^M.266$$

$$\overline{M}_{sp} - \overline{M}_{SH} = +0^M.100$$

It would thus seem that our parallaxes are systematically 13 per cent smaller than the trigonometric values and 5 per cent smaller than the spectroscopic. Owing to the peculiarities of our stars mentioned above, we can consider these results as very satisfactory.

If we consider the trigonometric parallaxes as perfect, we find that our absolute magnitudes are affected with a mean error of $\pm 0^M.66$ (corrected for the systematic error found above) or, in other words, that the mean error in our parallaxes amounts to 30 per cent. The corresponding values for the spectroscopic parallaxes are $\pm 0^M.52$ and 24 per cent. From much more extensive material Strömberg found 28 per cent for this last quantity.

THE PARALLAXES OF THE FIRST MAGNITUDE STARS.

By Knut Lundmark and Willem J. Luyten.

On account of the extreme difficulties in measuring parallaxes of very bright stars, the parallaxes of the first magnitude stars cannot yet be considered very good. In another paper we have estimated the degree of accuracy with which parallaxes can be predicted from spectral class and proper motion. The fact that several of the first magnitude stars are supergiants and have a small proper motion leads us to believe that we cannot expect the same accuracy here. Yet it seems that our parallaxes may add to the knowledge about the distribution of the first magnitude stars.

In Table I are given in order for each star: its name, apparent magnitude and spectral class, the absolute magnitude computed from proper motion and that computed from spectral class, the adopted mean and the corresponding parallax. The last four columns contain the trigonometric and the spectroscopic parallax and the values derived by Kapteyn and Charlier for the galactic helium stars.

For physical double stars the fainter components have also been used for estimating the parallax. The values for the absolute magnitude of the principal star as derived from these fainter components are then entered in a second line. For the actual computation of the absolute magnitude from the reduced proper motion and the spectral class the same system has been followed as that described in *Lick Observatory Bulletin*, **10**, 153, 1922, except that now the spectral subdivision has been used to interpolate between the values computed for the mean of a whole spectral class.

In regard to the mean absolute magnitude it may be mentioned that in the case of ordinary giants or dwarfs, such as α Canis Majoris and α Centauri, double weight has been given to the spectral parallax. In other cases equal weights have been assigned.

The agreement between our parallaxes and the trigonometric values considering only well established values (marked with an asterisk) is extremely good. The agreement is still fair in the other cases and only for α Cygni does our method seem to fail entirely.

The adopted parallaxes have been used to compute the distances $r \sin \beta$ *from* the galactic plane and those *in* it. Without regard to sign the mean values of $r \sin \beta$ is 13 parsecs, that of $r \cos \beta$ 80 parsecs (50 parsecs when giving weight 0.3 to α Cygni). The oblateness of the galactic system thus seems to appear even in the first magnitude stars.

TABLE I.

PARALLAXES OF THE FIRST MAGNITUDE STARS.

Name	Mag.	Spec.	M_H	M_S	M	$\pi_{S,H}$	$\pi_{trig.}$	$\pi_{spec.}$	$\pi_{Kapteyn}$	$\pi_{Charlier}$
	M		M	M	M	"	"	"	"	"
α Eridani	0.60	B5	−1.8	−0.5	−0.9	0.050	0.041			0.052
α Tauri	1.06	K5	−0.3	+0.5	+0.2	.066	.064*	0.096		
α Aurigae	1.0	G0	+1.0	−0.6	−0.2	.058	.063*	.076		
			+1.0	−0.6						
			+1.4	−0.0						
β Orionis	0.34	B8	−6.3	.....	−6.2	.005	.003		0.007	
			−5.3	−6.9						
α Orionis	0.92	Ma	−2.9	.....	−2.9	.017	.022*	.012		
α Carinae	0.86	F0	−4.4	−2.5	−3.8	.026	.003	.048		
α Can. Maj.	1.58	A0	+1.0	+1.2	+1.1	.347	.366*	.376		
α Can. Min.	0.48	F5	+2.2	+3.5	+3.1	.331	.310*	.347		
β Gemin.	1.21	K0	+1.2	+1.0	+1.1	.096	.095	.126		
α Leonis	1.34	B8	+0.3	+1.0	+0.5	.066	.045			
			−0.5	+0.5						
α Crucis	1.58	B1	−2.2	−2.7	−2.7	.014	.002		0.014	.008
			−2.1	−3.2						
			−1.9	−4.0						
β Crucis	1.50	B1	−2.0	−2.7	−2.3	.017	.005		.017	.014
α Virginis	1.21	B2	−2.3	−2.7	−2.5	.018	.022			.017
β Centauri	0.86	B1	−3.3	−2.7	−3.0	.017	.027		.011	.019
α Bootis	0.24	K0	+2.0	+1.0	+1.3	.158	.105	.158		
α Centauri	0.33	G2	+3.1	+4.6	+4.7	.759	.763*	.794		
			+4.7	+5.6						
α Scorpii	1.22	Ma	−2.6	.....	−3.7	.010	.019	.017		
			−2.9	−8.7						
α Lyrae	0.14	A0	−0.2	+1.2	+0.7	.132	.134*			
α Aquilae	0.89	A5	+2.0	+2.2	+2.1	.174	.214*			
α Cygni	1.33	A2	−8.5	.....	−8.5	.0011	.012			
α Pisc. Austr.	1.29	A3	+1.2	+1.5	+1.4	.195	.128			

NOTES ON THE TABLE.

α Tauri — Many trigonometric parallaxes, but a discordant case.

α Aurigae — $\pi = 0''.0632$ derived by Merrill from interferometer measures. It probably is the most accurate parallax known. From interferometer measures and from the mass ratio it follows that the two components are very probably nearly equal in brightness; accordingly $+1^M.0$ was adopted for each.

β Orionis — Kapteyn finds a hypothetical parallax of $0''.069$.

α Leonis — Parallax from Yale for the fainter component.

α Crucis — Cape has $0''.050$, Voûte $0''.00$, weighted mean uncertain.

α Virginis — Cape parallax.

β Centauri — Cape parallax.

α Bootis — Shapley derives a spectroscopic parallax of $0''.209$.

α Lyrae — Agreement good, but the trigonometric parallax uncertain as yet as the different values are discordant.

α Scorpii — From the assumption that the star belongs to the Scorpio-Centaurus group Adams and Joy derive a parallax of $0''.009$.

α Aquilae — Hertzsprung derives a parallax of $0''.145$ assuming the star to belong to the Taurus stream. The trigonometric parallaxes seem to point to a somewhat closer distance than that demanded by Hertzsprung.

α Cygni — Hubble has suggested a connection with the North America Nebula. The parallax of the latter is about $0''.005$ which is not in contradiction to the very uncertain parallaxes given here.

ON THE INFLUENCE OF THE SYSTEMATIC ERRORS IN BOSS'S PROPER MOTIONS ON THE MEAN PARALLAX OF THE CEPHEIDS.

By Willem J. Luyten.

In his valuable memoir, "On the proper motions of the faint stars and the systematic errors of the Boss fundamental system" (*Bulletin Astronomical Institutes of the Netherlands*, **1**, 69, 1922), Kapteyn derived a correction to the Boss μ_δ's of $+0''.013 \cos \delta$. It is evident that a correction of this kind will have a large influence on stars of small proper motion such as the Cepheid variables. To test the possible effect of this correction on the mean parallax of these stars as derived from the parallactic motions, the v and τ components of the proper motion were computed anew after applying Kapteyn's correction term to the Boss μ_δ's.

For the 11 Cepheids used by Shapley the results are:

$$\overline{v \sin \lambda} / \overline{\sin^2 \lambda} = 0''.0079 ; \text{ and accordingly } \pi = 0''.00174 \text{ and } M = -3^{M}.8$$

reduced to apparent magnitude $5^{M}.0$ and computed with elements of the solar motion: $A = 270°$, $D = +30°$, $V_0 = 21.5$ km/sec. For the peculiar motion τ we find $\overline{\tau} = +0''.0047$.

For comparison we cite Hertzsprung's, Shapley's and Kapteyn and van Rhijn's values reduced to $5^{M}.0$ and 21.5 km/sec.

Hertzsprung	0".0034
Shapley	0.0034
Kapteyn and van Rhijn	0.0031

All these mean parallaxes were derived from the Boss proper motions without applying the corrections advocated by Kapteyn.

In another paper I have shown that results obtained from large proper motions and from latitude variation are not consistent with Kapteyn's correction term. It would thus seem wise, for the present at least, not to infer a too definite conclusion.

RECENT ADVANCES IN PHOTOGRAPHIC THEORY.

By C. E. K. Mees.

A good deal of study in the last few years has been devoted to the structure of the sensitive surface of photographic materials. This surface is composed of individual crystalline grains having a considerable range of sizes. The distribution of the grains of different sizes has been investigated and curves obtained which can be related to the photographic properties of the materials. Much work has been done

on the nature of sensitiveness and of the latent image which is produced by the action of light upon the grains. Some workers hold that the grains contain centers of sensitiveness formed when they are made, while others consider that centers are produced by the action of the light, one theory being that light acts in discrete units, each unit having the energy of a quantum. These various theories are discussed and suggestions made for further work upon the subject.

SYSTEMATIC CORRECTIONS TO STELLAR PARALLAXES.

By John A. Miller and John H. Pitman.

The published parallaxes of the different observations have been examined for systematic error by the method described below. Where two or more determinations of the parallax of a star have been made, each determination having a probable error not greater than 0″.020, the observations were combined by weighting the determinations according to the probable error. The system of weights used was as follows:

Probable Error	Weight
0″.000 — 0″.010	1.0
0.011 — 0.014	0.7
0.015 — 0.017	0.5
0.018 — 0.020	0.3

The spectroscopic parallaxes were not included in the averages. From the average parallax thus formed for any star was subtracted the individual determinations of the parallax of the same star. The residuals thus found are collected in the following table:

TABLE I.

Average Minus	No. of Cases	Algebraic Average of Residuals	Arithmetical Average of Residuals
Adams	356	—0″.0047	±0″.0159
Kapteyn	387	—0.0013	±0.0254
Hirayama	345	—0.0015	±0.0244
Sproul	117	—0.0002	±0.0128
Allegheny	284	+0.0019	±0.0100
McCormick	262	+0.0003	±0.0109
Yerkes	149	+0.0027	±0.0139
Van	47	—0.0034	±0.0110
Fox	54	—0.0066	±0.0185
Smith, Chase, Elkin	61	—0.0043	±0.0266
Greenwich	28	—0.0046	±0.0131

It is of course evident that, as the number of determinations of any observer increases, the influence of a few large residuals will become relatively smaller. Also the inclusion or exclusion of a few large residuals will have a greater relative effect upon the algebraic mean than on the arithmetic mean.

Arrangement according to magnitude of the Sproul Observatory determinations showed no evidence of magnitude correction.

SURFACE FEATURES OF THE MOON, THE EARTH, AND MARS.

By John Millis.

The two best known theories to account for the surface features of the moon—volcanic action and impact by meteors—are both strangely plausible to a certain degree, considering their radically different character, and the idea is advanced that a reconciliation of the two may be possible, with a resulting general theory more complete and satisfactory than those that have been advanced heretofore.

Imagine the moon to be built up wholly or largely by the agglomeration of constituent masses coming together under mutual gravitation attraction. The impacts and the process of coalescence will develop heat, and the interior of the growing mass will become liquified in whole or in part. The external bodies or masses will penetrate a crust upon striking and will be absorbed, while the orifice so formed will be partly or entirely filled with liquid matter from within. With the growth and expansion of the principal mass by these additions its surface will be extended, and this will enlarge and distort the surface rings and ridges already formed by the impact of the external masses. These impacts by enlarging the volume and expanding the surface will also cause cracks and outflowing of lava in localities more or less distant from the places of impact, and a repetition of such action will produce several superposed lava sheets in certain areas. As the central mass approaches the present size of the moon, and perhaps also for the reason that the bodies that arrive later are of smaller size than the earlier ones, the effects of surface expansion will become relatively less, and the crust will be less liable to be penetrated, so that the later formed scars of impact more closely resemble effects that can be produced artificially on a small scale, as in the marks of projectiles on a steel target, or by dropping bombs to the earth's surface from an air plane.

These assumptions explain the large, fairly smooth, and lava-covered areas of the moon's surface that are roughly circular in shape, and that were formerly called "seas," and the rude terraced formations around the rims of some of the crater pits found in such areas which indicate that the lava exists in several layers or strata. The theory also accounts for the fragmentary curved lines of elevations and peaks designated as mountain chains. The large circular rimmed areas floored and partly filled with lava, and the great circular pits, often with a central pinnacle, that so strikingly suggest volcanic craters, are reconciled and accounted for as due to similar causes.

There are many forms on the surface of the earth that suggest some process of formation analogous to that above described, though this must have been at a period greatly anterior to the phenomena that produced the present surface features of the moon, and on the earth these results have been much obscured and largely obliterated by subsequent

events. The features referred to comprise certain well-known curvilinear arrangements of island chains and mountain ranges, great areas covered with overflow of lava in several strata, and evidences of expansion from within the earth's mass with cracking and opening of the exterior crust, as in the wadys, fjords, "canals," and canyons in various localities.

Throughout the voluminous collection of drawings that have been made of the surface of the planet Mars there will be found many significant forms consisting of patches with circular boundaries, cusps and peninsulas with curved outlines, and numerous spots or "oases," that may well be immense crater-like areas similar to those of the moon, having possibly a similar genesis.

There seems to be a strong probability of relationship among the phenomena that have produced these features on the three bodies considered, and the "planetesimal" hypothesis appears to be the cosmological theory that derives most support from these considerations.

A COMPARISON OF CLOCK CORRECTIONS DETERMINED WITH LARGE INSTRUMENTS.

By H. R. Morgan.

During the five years, 1913.5-1918.5, there were 397 clock corrections determined nearly simultaneously, on the same nights, with the 9-inch transit circle and 6-inch transit circle of the U. S. Naval Observatory. The same clock was used; and the same system of star places, the stars of the same general declination between $+30°$ and $-20°$ were used.

Corrections for the personal equations of the ten observers, and for difference of longitude of the two instruments, having been applied, the definitive clock corrections were run together using definitive clock rates, and the differences formed. These differences in the clock corrections from the two instruments vary as much as $0^s.2$ or more, in short intervals, but it was at once seen that this variation was due to the clamp positions of the instruments. As compared by clamp groups the differences each side of a reversal were found to be $0^s.12$ for the 6-inch and $0^s.06$ for the 9-inch. These differences apply only to the stars in the region covered by these clock stars, and the differences for clock stars at the zenith are not the same. These clamp terms for the two instruments are persistent, but they vary by half their amount from the means. A discontinuity of $0^s.044$ was found in the relative clock corrections each side of November 20, 1915, at which date an entirely new system of relays was introduced in the clock circuits. Of the 397 differences in clock corrections further corrected to the mean clamp of both instruments, only four differ as much as $0^s.1$ from the mean.

It appears that these instruments held closely together for the five years, the noticeable feature of the comparison being the change with

change of relays, and especially the clamp terms which must be taken account of in absolute time or longitude work. This cannot be done when preliminary reductions have to be made for a time signal sent a few hours after the observations have been made. These clamp terms vary $0^s.1$, and changes of this size are liable to occur in the signals.

However, the comparison shows that by using two instruments it is practicable by definitive reductions to find later the proper corrections to the signals as sent, and to reduce their uncertainties to $0^s.02$, or $0^s.03$, as far as the observations go.

A REVISED LIST OF THE OLIVIER DOUBLE STARS.

By Charles P. Olivier.

A revised list of the double stars discovered by the writer from 1906 to the present and numbering 110 in all is presented along with notes relative to them. In distribution 35 have northern and 75 have southern declinations. The B. D. or C. P. D. catalogues contain 44 of the stars, leaving 76 identified by coördinates only. The following table gives the distribution:

0″.50 to 1″.00	10
1.00 " 2.00	35
2.00 " 3.00	28
3.00 " 4.00	24
4.00 " 5.00	12
5.00<	1
	110

Theye were all discovered with the 26-inch McCormick telescope and the 12-inch Lick telescope, 75 with the former and 35 with the latter instrument. Of the former group, 60 were visually discovered and 15 upon parallax plates. It should be emphasized that many faint pairs of from 3″ to 5″ separation were not recorded at all, and further that only a very small fraction of the total time available for measuring double stars was spent in attempting to discover new ones. Most of these latter were found quite casually.

NEW SILICON LINES IN CLASS B STARS.

By W. C. Rufus, R. A. Sawyer and R. F. Paton.

Silicon has long been recognized as an element the spectrum of which is very difficult to obtain in the laboratory. It has further been noted by Lockyer and others that very marked changes in the relative intensities and appearance of silicon lines were produced by variation of the mode of excitation. In fact the lists of lines given by different observers show wide variations in the number and wave-lengths of the lines listed.

The presence of silicon absorption lines in stellar spectra was early

noted by Lockyer and Huggins. At the present time nearly all of the strongest lines of silicon from λ3700 to λ6600 have been identified in stellar spectra. The progressive change of intensity of certain silicon absorption lines with stellar spectral class has been established by Pickering and others. For example, λ4089 and λ4116 reach maximum intensity in Class B0 and decrease rapidly, while λ4128 and λ4131, stronger in the vacuum spark than the preceding, are absent or very weak in Class B0 and increase in intensity throughout the succeeding subdivisions of Class B. It has also been noted that certain stars of the subclasses have stronger silicon lines than others of corresponding classification, also Frost and Adams have pointed out that these same stars show a corresponding increase in the intensity of the oxygen and nitrogen lines. The anomalous behavior of silicon emission in P Cygni, a Class B star with bright lines in its spectrum, has been discussed by Merrill and others. In the spectrum of this star bright silicon lines, non-centrally superposed on broad absorption lines, show a displacement too great to be ascribed entirely to the Doppler effect.

A recent laboratory investigation of the silicon spectrum by Rufus and Paton, using as a source the vacuum spark, has revealed the existence of a very large number of new lines, extending the list of known lines about fivefold. That is, there were emitted under the violent excitation of the silicon radiations not excited by ordinary modes of excitation.

It has seemed to us of interest to examine the lists of lines found in the spectra of Class B stars to see whether any of the unidentified stellar lines show coincidences with new silicon lines. The large number of such coincidences in the case of ρ Leonis found by one of us is given in the lower part of the accompanying table.

TABLE I.

SILICON LINES IN ρ LEONIS.

Sawyer and Paton	I	ρ Leonis	I	S and P — ρ
4088.88	6	4089.06	4½	—0.18
4116.15	6	4116.19	1	—0.04
4128.11	8	lacking		
4130.96	10	"		
4552.50	20	4552.63	5	—0.13
4567.66	16	4567.79	3	—0.13
4574.66	12	4574.74	2	—0.08
4813.28	3	4813.6	s	—0.3
4819.57	4	4819.2	½	—0.4
4828.84	6	lacking		
COINCIDENCES WITH NEW SILICON LINES.				
4304.15	0	4304.0	1	—0.15
4372.33	1	4371.9	½	—0.4
4638.36	1	4638.60	1	—0.24
4665.76	1	4665.6	s	—0.2
4709.20	1	4709.4	s	—0.2
4800.43	1	4800.1	s	—0.3
4837.97	1	4837.8	½	—0.2

The first part of the table exhibits ten previously known silicon lines. Columns 1 and 2 give the wave-lengths and relative intensities in the vacuum spark, columns 3 and 4 contain the wave-lengths and relative intensities in the star as determined by Dawson, and column 5 gives the differences in wave-lengths, spark minus star. The relative intensities in the spark and in the star show an utter lack of correspondence; consequently, since silicon series relationships have not been definitely established, a consideration of line intensities will give little or no aid in determining identities between silicon spark lines and stellar absorption lines. The differences in wave-lengths of previously known lines found in the spark and in the star led to the adoption of 0.4 A as the provisional maximum limit in recording coincidences. There is little reason to doubt that the seven close coincidences in the case of ρ Leonis represent new identifications. Five of these seven lines are members of pairs with the same frequency difference as the pair 4088.88 — 4116.15.

As a stellar source of light reveals a mixture of various elements, under different conditions in individual stars, it may be of interest to include some of the so-called impurities of the silicon spark spectrum in relation to the Class B stars. Of the seven lines attributed to oxygen from λ4076 to λ4661 in the spectra of δ Orionis and ϵ Orionis by Curtiss, all excepting the last one are found among our impurities. In a similar region of the spectrum twenty-one lines in the spark are attributed to oxygen, of which all excepting three are given by Henroteau and Henderson in their table of lines of Class B stars. Four nitrogen lines in the spark are all found in the stars. λ4607.30 in the spark was rejected from the list of silicon lines and ascribed to nitrogen altho its intensity (2) being so much greater than the intensity (0) of the other nitrogen lines leads to the conclusion that silicon probably contributes to the strength of the radiation. Hα, Hβ and carbon λ4267 are also found among the impurities. The presence of such a large number of Class B stellar lines among our impurities strengthens the conviction that the vacuum spark source closely approaches the condition of the early type stars.

In addition to the seven coincidences between new silicon lines and absorption lines in ρ Leonis, ten have been found with other unidentified absorption lines of Class B stars at wave-lengths 3230.43, 3779.47, 4141.04, 4494.02, 4598.21, 4619.60, 5219.05, 5448.46, 5639.13 and 5796.71. It is quite probable that many of these stellar lines are due to silicon absorption.

Among coincidences noted between previously known silicon lines and stellar absorption lines not identified by the observers, λ3806.60, the strongest silicon spark line in this region, corresponds with λ3806.4 observed by Kohl in γ Orionis the only unidentified line measured by him in the ultra-violet. Pickering's line λ3790.0, not found by Kohl, may be

due to λ3791.13 of the spark. The absorption line λ4198.34 found by Curtiss in β Lyrae shows close correspondence with λ4198.25.

It was not our original intention to include a study of coincidences between the silicon spark lines and stellar emission lines. However, a few remarkable cases seem worthy of mention in this connection.

Three formerly known silicon lines λ3853, λ3856 and λ3862, which show some disagreement in wave-length in the spark, are represented in the spectrum of β Lyrae, a Class Bp spectroscopic binary, by three bright lines λ3853.61, λ3856.45 and λ3862.55 measured by Curtiss. Our wave-length for these lines are 3853.01, 3856.09 and 3862.51. Although there is a greater discrepancy in two of the lines than we have admitted in the case of absorption lines, the anomalous behavior of the radiation, both in the spark and in the star, gives strong evidence in favor of the identification. Two new silicon lines λ4657.20 and λ5185.64 may be represented by emission lines in γ Cassiopeiae; while others appear suspicious.

A very remarkable set of coincidences between the silicon spark lines and the radiations of the Wolf-Rayet stars, γ Velorum and H. P. 1311, has been noted (by W. C. R.). Between λ3890 and λ5800 of the stellar spectrum there are as many as eighteen coincidences between measured lines, including both emission and absorption, and measured edges of lines, as given by Pickering.

The large number of coincidences between the new silicon lines and the absorption lines of Class B stars, especially ρ Leonis, and the coincidences between the silicon spark lines and emission lines of early type stars lead to the conclusion that silicon plays a more important part in stellar radiation than has usually been ascribed to it.

A more extensive study including other stellar spectral classes might lead to interesting results.

SOME RESULTS OF A STUDY OF VISUAL DOUBLE STARS.

By Henry Norris Russell.

A card catalogue has been made, at the Princeton University Observatory, of all double stars showing relative motion, and dynamical, or "hypothetical," parallaxes have been derived for about 1600 pairs which show evidence of physical connection.

The statistical theory of the determination of parallaxes from short arcs of orbit has been investigated. The method of Russell and Hertzsprung appears to be the most generally useful. The errors arising from adopting a mean value for certain factors which vary from star to star have a distribution corresponding almost exactly to a probable error of twenty per cent of the tabular parallaxes, and the dynamical parallaxes are comparable in accuracy with spectroscopic determinations—or trigonometric, except for the nearest stars.

The relation between mass and absolute magnitude among these

1600 stars is in close agreement with that found from Jackson and Furner's data by Seares, except for the B-stars, which are considerably brighter per unit of mass.

Comparison of dynamical and spectroscopic parallaxes of more than 300 stars (of which a list was generously furnished by Adams) indicates that the mean difference of the two, and hence the mean mass of a system, depends (at least as a matter of statistical averages) upon the absolute magnitude, rather than the spectral type. The red giant and white dwarf stars, which are very discordant on an ordinary diagram, fall perfectly into line, when mass is plotted against absolute magnitude instead of spectral type. More detailed statements are deferred till a comparison can be made with the trigonometric parallaxes.

DESCRIPTION OF THE LOOMIS COELOSTAT TELESCOPE OF THE YALE UNIVERSITY OBSERVATORY.

By Frank Schlesinger.

The Loomis coelostat telescope is a memorial to Elias Loomis, for many years professor of natural philosophy and astronomy in Yale College. The optical parts were made by the Brashear Company, the mechanical chiefly by Warner and Swasey. The instrument consists of a plane mirror thirty inches in diameter, mounted equatorially and driven by clockwork at the diurnal rate; this mirror can be pointed in every direction so as to throw a beam of light from any configuration upward through a long steel tube parallel to the earth's axis, at the lower end of which are a fifteen-inch photographic objective and a ten-inch visual objective, both of fifty-foot focal length. They form images in a room at the top of a sixty-foot brick tower. This room can be heated, and the observer sits in a comfortable position, manipulating the telescope very much as though he were working with an ordinary microscope. Electrical appliances enable him to set the telescope on any object without leaving his chair, and a small telescope permits him to read the setting circles near the mirror sixty feet below. The plate holder is also rotated at the diurnal rate by means of a driving clock.

The advantages of this form of telescope are its saving in cost (this being perhaps one-third of what a telescope of equal focal length would require if mounted in the ordinary way) and the convenience of the observer. Its disadvantage, which applies as well to all other telescopes in which oblique reflections are used, is the presence of astigmatism when the temperature is changing rapidly.

The Loomis telescope is at present being used for the photometry of variable stars by means of the measurement of the density of star images. For this purpose it proves to be efficient and accurate.

THE SPECTROSCOPIC RYDBERG CONSTANT AS INFLUENCED BY THE WOBBLING OF THE NUCLEUS FOR ATOMS WITH MORE THAN ONE ELECTRON.

By Ludwik Silberstein.

The electrons being assumed not to interact with each other but only subject to the attraction of the nucleus, the wobbling of the latter is investigated, up to second order terms, for any stationary quasi-Keplerian, especially quasi-circular orbits described by the electrons. This gives the energy of the system and, through it, the Rydberg coefficient corresponding to any combination of quantum numbers determining the orbits of the electrons. If these integer numbers are all different, the Rydberg constant becomes equal to $N_\infty (1 - m/M)$, where m, M are the masses of a single electron and of the nucleus respectively, and N_∞ is the Rydberg constant for an infinitely massive (non-wobbling) nucleus. If some, or all, quantum numbers are equal, there is an additional term depending on the mutual inclination of the orbits and the phase difference of the electrons describing them. The total value of the Rydberg constant is then contained within a certain range symmetrical with respect to the aforesaid value. The extreme values are, e. g., in the case of two electrons, N_∞ and $N_\infty (1 - 2m/M)$.

DIFFERENTIAL EFFECTS OF ATMOSPHERIC DISPERSION UPON STARS OF DIFFERENT COLORS.

By Frederick Slocum.

Systematic errors in stellar parallaxes determined by the trigonometrical method appear to be different for stars of different colors. It has been suggested that this may be due to differential atmospheric dispersion.

To test this a pair of stars, one red, the other blue, (spectral types, Mb and B5) was selected and the field photographed with the 20-inch refractor of the Van Vleck Observatory at hour angles varying from 0^h to $4^h\ 30^m$. Isochromatic plates and a color filter were used.

The positions of the colored stars were measured with respect to six comparison stars of about the 10th magnitude. From 40 exposures on 20 plates the displacement in zenith distance at altitude 45°, relative to the group of comparison stars is

for the red star	$-0''.025 \pm 0''.019$
and for the blue star	$+0''.016 \pm 0''.019$

The signs are as would be expected, refraction raising the blue star more and the red star less than the faint comparison stars, probably of about type F. For parallax work only the components of these values in right ascension need be considered and these are so small that for plates taken within an hour of the meridian no appreciable errors can be introduced.

NOTE ON THE COMPARATIVE PRECISION OF FOCAL AND EXTRA-FOCAL METHODS IN PHOTOGRAPHIC PHOTOMETRY.

By Harlan True Stetson.

At previous meetings of the Society results have been reported for the probable error in magnitude of a single image on a photographic plate where focal images of about 0.2 mm in diameter were involved. In the present instance an investigation was made to determine what would be the probable error in magnitude when a blackened surface was measured, as would be the case in the extra-focal methods in photometry. The plate was accordingly placed in a holder directly behind and in contact with a grid which should give alternate exposed and unexposed regions. The plate was then exposed to a source of illumination rendered as nearly uniform as possible through the use of multiple diffusing screens and was rotated by a motor throughout the exposure so that any lack of uniformity in the illumination should appear as systematic differences in opacity concentric about the geometric center of the plate. Some forty or fifty spots were selected on the resulting plates for measurement of opacity with the thermo-electric photometer. Readings on the clear glass channels between the exposed strips were taken in every instance to eliminate glass and gelatine absorption as usual. A system of standard squares of known magnitude differences as used at the Harvard College Observatory by Professor King was imposed for giving the plate gamma. Measures of opacities in this way give a direct indication of the magnitude of the errors which would be involved in the method of extra-focal measures due to lack of uniformity in plate sensitivity. The probable error for a single image was found to be of the order of $0^{M}.035$ or about fifty per cent larger than the results for focal images. Furthermore, decided tendencies to systematic distribution of plus and minus residuals left little doubt that the major part of the difficulty lies in the manufacture and application of the emulsion to the plate itself and that the use of plate glass does not probably modify the results of extra-focal measures appreciably.

THE OPACITY OF AN IONIZED GAS.

By John Q. Stewart.

Theoretically the absorption of radiation by free electrons should render an ionized gas highly opaque. The organized vibrational energy, due to the radiation, of the free electrons is transformed by collisions into disorganized thermal energy of translation. A tentative application of the methods of the well-known free electron theory of the optical properties of metals to conditions in an ionized gas gives a formula for the opacity.

The experimental work of Dr. Anderson at Mt. Wilson has shown that the opacity of the vapor of an exploded iron wire under certain

conditions is such that light is cut off in a distance not greater than a few centimeters. Application of the new formula indicates that the absorption of radiant energy by the free electrons in the doubly ionized iron vapor produces an opacity of this order of magnitude. Application of the formula to conditions in the outer regions of the sun, employing Saha's theory to calculate the ionization as a function of the unknown gas pressure, makes it seem probable that at a depth in the sun where the pressure is as great as 0.01 atmosphere the ionized gas is sufficiently opaque to cut off radiation from farther down. This is, then, indicated as the approximate pressure in the solar photosphere; and pressures in the solar atmosphere are much lower. Thus the sharpness of the Fraunhofer lines may be explained.

THE RECORDING OF WIRELESS TIME SIGNALS AT ELGIN DURING 1922.

By Frank D. Urie.

The Elgin Observatory has been recording wireless time signals on the electro-chronograph since 1914. This is at present accomplished by means of a special "sound relay" designed by the writer. The wireless signals in the phones of the ordinary receiving apparatus actuate the sound relay, which in turn controls the movement of the chronograph pen.

This paper gave a statistical account of the various wireless time signals recorded during 1922; these include 251 records of the Washington noon signals from Arlington and Annapolis, 40 records of the French rhythmic signals from the Lafayette Station, Bordeaux, France, and 3 records of the Berlin time signals from Nauen.

PARALLAX NOTES.

By Adriaan van Maanen.

The parallax of α Orionis, derived from eighteen exposures, taken at the 80-foot focus of the 60-inch reflector, was found to be $+0''.011 \pm 0''.006$. For this object parallaxes by the Yale, Allegheny, and Yerkes observatories, are available, besides the spectroscopic parallax derived by the Mount Wilson observers. Using the weights and corrections derived in *Mount Wilson Contribution* No. 189, we find a mean parallax of $0''.017 \pm 0''.002$. The diameter, according to Pease's measurements, ranges from $0''.035$ to $0''.055$, or, from 190 to 300 million miles (on the assumption $\alpha = 1.22\lambda/D$).

Recently four parallaxes have been derived with the 100-inch reflector. The Newtonian arrangement was used with a focal length of 42 feet. The results are collected in the table.

Object	Phot. Mag.	μ	π abs.	p. e.	M phot.
Wolf 1037	14.5	1".57	+0".055	0".004	+13.2
" 1039	13.8	1.44	+0.057	0.004	+12.6
" 1040	14.5	1.23	+0.058	0.007	+13.3
N.G.C. 7293	13.3	....	+0.039	0.005	+11.2

The motion of the three Wolf stars at right angles to the line of sight are of the order of 110 km/sec. The last object, N. G. C. 7293, which is the so-called "helical nebula," is the giant of the planetaries; its diameter is 15′, which, with the parallax of 0".039, gives a diameter 375 times that of the orbit of Neptune.

THE FRAUNHOFER LINES.

By Frank W. Very.

The lines in the solar spectrum do not vary in strength between the center and limb of the sun, differing in this respect from the depletion of short waves by atmospheric scattering, which increases towards the marginal zones. This behavior of the lines is due to the fact that, after a certain depth of the absorbent layer is surpassed, no further increase in line-absorption takes place. In nearly every case this effective absorbent layer is everywhere exceeded.

The width of the lines increases with the pressure of the gas, either in emission or absorption, but here again, not beyond a certain limiting value.

I found that the radiation of hot carbon dioxide at atmospheric pressure increases with the depth until the radiant layer reaches about one meter, beyond which the radiation remains constant. This, therefore, is the effective depth of the radiant layer for this gas. The spectrum is a discontinuous one.

Certain lines in the solar spectrum, such as the strong ultra-violet lines of iron, have broad nebulous wings fading away on either side of a strong central core. The accession in width comes from the action of the higher pressure gas in deeper layers. That this high-pressure absorption is no stronger may be partly due to the small thickness of the layers which alone attain the pressure needed to produce the effect, but it comes in part from an admixture of other atoms which begin to radiate feebly, but continuously, since the region in question is close to the photosphere.

Anderson finds that a few centimeters of the vapor of iron, formed by the electric explosion of a fine iron wire, are completely opaque and emit a continuous spectrum, which is not produced by a broadening of the iron lines, for these are still visible as fine dark lines from an excessively thin cooler marginal layer. The pressure is estimated to be about 20 atmospheres, and the collisions between the atoms at this pressure and at the estimated temperature of 20,000° K. are sufficiently numerous to set the thousands of mass-giving electrons within each iron atom oscillating under the tremendous impacts of the explosion.

Here then is the source of the photospheric radiation, and we see that no great depth of gas is needed to produce it, if about 5 cm of exploded iron vapor can give a good imitation of the sun's surface, and even exceed it in intrinsic brilliancy. The experiment overthrows the hypothesis that an enormous depth of gas is needed to produce the continuous spectrum through broadening of the emission lines of a heated gas under pressure. In the first place, this broadening of the lines only takes place to a limited extent, and next the lines of the luminescence are produced by a comparatively small number of the supernumerary electrons whose vibrations do not affect the much larger number of the mass-giving electrons which require the thermal excitation of an explosion, or its equivalent, to set them vibrating.

The continuous radiation, as has been shown, is essentially a surface radiation, and the early conception of a photospheric *surface* still holds good. This surface is a billowy or corrugated layer. In measuring the intensity of the Fraunhofer lines, I find that the feeblest of them, especially those which belong to the very heavy metals and come from the lowest levels, do not have continuity, but are visible only as separate spots, giving a beaded look to the lines. I conclude that these lines are produced by gases of so great density that they occur chiefly in the depressions of the photospheric surface.

The appearance of the lines also depends very largely upon electrical conditions. Some of the strongest metallic lines disappear with the introduction of self-induction and are not found in the sun; while some of the most persistent lines are of feeble intensity. Possibly the local electric conditions may here be the more significant ones.

SIMPLE RULES FOR ADJUSTING AN EQUATORIAL TELESCOPE.

By Worcester R. Warner.

Items not needed: latitude of observatory, longitude of observatory, sidereal clock, mean time clock, chronometer, equation of time, compass, theodolite, level.

Items needed: Nautical Almanac, yard of thread, monkey wrench, screw driver.

After carefully assembling the telescope, test each element separately, and be sure the driving clock and each clamp and slow motion function correctly.

Next, place the declination axis level (estimated) and set the telescope tube at right angles to the polar axis (estimated), using the clamps and slow motions.

Correct the leveling of the declination axis by a fine thread tied near the top of the coarse declination circle, letting it hang over the outer or inner edge and attach to it any small weight, a pocket knife for example, and use it as a plumb line for bringing the edges of the

declination circle to a vertical position, for then the declination axis will be level.

Next, set both circles to read zero.

At this point wait for a clear evening, for the stars will do the rest. Such an evening having arrived, we are ready for the second chapter of our simple problem.

Direct and clamp the telescope to a prominent star chosen from the Nautical Almanac (pages 94 and 95, 1923) near the equator and a little east of the meridian. By first using a low power eye-piece, and then a high power, bring this star by the slow motions exactly in the center of the field. Adjust the finder on this star.

Note the reading of the coarse declination circle, then reverse the telescope to the other side of the pier and repeat the observation, again noting the reading of the declination circle.

Observe the difference between these two readings, and change the position of this circle by half this difference, and repeat the observations again on each side of the pier. The second series of observations will show results very nearly alike, and by repeating this test a few times the declination circle will be set correctly.

Compare this last declination reading with the declination of this star as recorded in the Nautical Almanac, and correct the error by adjusting the elevation of the polar axis (keeping the star in center of field) until the declination circle reads the correct declination of this star.

It will be interesting to try these tests on several stars near the meridian and at greater distances from the equator.

Next take stars quite a distance to the east and to the west, and these will probably show errors in the declination reading. We must not, however, change our declination circle, for these errors are in azimuth. The direction in which they occur as we try them to the east and to the west, will indicate in which direction we must swing the base of the telescope in order to bring the polar axis in coincidence with the celestial pole. It may require more than one evening to make the repetition tests, but interest will be aroused as a high degree of accuracy is reached.

All the tests mentioned are with the coarse circles, the use of which will make the fine circle adjustments easy.

The coarse declination circle should be as large as is practicable, and graduated in degrees and figured each ten degrees from zero to ninety in each direction, and back to the opposite zero.

If the width of the graduation mark is one-half of a degree on the circle and the pointer, it will aid in setting the telescope to fractions of a degree.

The coarse hour circle should be graduated to five minute spaces, the hours to be numbered from zero to six in each direction, and back to the opposite zero.

It is hoped that the simplicity of these adjustments will commend the problem to teachers as a good one for the bright student to solve, by first placing these elements out of adjustment and then systematically adjusting the circles and the axes and the pier to their correct positions.

THE PROPER-MOTIONS OF 74 CEPHEID VARIABLES.

By Ralph E. Wilson.

Modern estimates of the size of the universe are based primarily upon the proper-motions of but eleven Cepheid variables and are, therefore, subject to a large degree of uncertainty. This paper presents new proper-motions of seventy-four stars of this class, derived from meridian observations collected from all available sources and including the unpublished San Luis and Albany observations in the years 1908 to 1917.

The motions of the stars are shown to be extremely small in general, only two of them exceeding 0″.2 per annum, and the mean of the remaining seventy-two stars being 0″.025 per annum.

Solutions for the coördinates of the solar motion referred to these stars give

$$A = 242^\circ \qquad D = +48^\circ \qquad M = 0''.0132$$

From the radial velocities of twenty-five of the stars the following coördinates of the solar motion are derived:

$$A = 286^\circ \qquad D = +35^\circ \qquad V = -21 \text{ km/sec.}$$

From the two values of the solar motion is derived a mean parallax of this group of stars,

$$\pi_m = 0''.0030$$

This is shown to be 1.77 times the parallax assigned by Shapley to these stars from a consideration of the motions of eleven of the brighter Cepheids. Computation of the parallactic motion directly from the individual stars indicates a factor, 1.61.

Dividing the material into three groups including the stars with periods <1, 1.9 to 15, and >15 days, the following results appear:

Group	No.	π_m	π_{Sh}	Factor	Wt.
1	17	0″.0034	0″.0011	3.1	0.3
2	40	.0033	.0022	1.5	1.0
3	14	.0001	.0004	0.25	0.2
		Mean factor		1.65	

The decrease in the factor appears real but needs further investigation.

The data, however, indicate that Shapley's parallaxes of the Cepheid variables should be multiplied by a factor, approximately 1.7. That

this factor is essentially correct for the thirteen stars for which trigonometric parallaxes are available is shown by a comparison of the two sets of parallaxes.

THE PROPER-MOTIONS OF 315 RED STARS.

By Ralph E. Wilson.

Soon after the publication of *The Proper-Motions of 154 Red Stars* in January, 1922, observations of a large number of these stars by Gyllenberg at Lund in the years 1917 to 1920 were received and additional observations, especially of the southern stars, became available from other sources. A re-examination of the data, including some of the older catalogues, which in the first investigation were considered of too small weight, has been completed. The proper motions of 315 of these stars have been determined, 226 of the determinations having probable errors $\leqq$ ″.015 per annum in either coördinate.

The weighted mean proper motions by spectral classes are:

Class	μ	No.	Wt.
Mc, Md	0″.0439	158	124.2
R	.0299	34	24.8
Pec.	.0295	13	12.0
N	.0252	92	82.9
Unknown	.0350	18	15.7

The Class N stars are so distributed on the sky as to vitiate any determination of the solar motion or of their own peculiar motion. They should not be combined with the other stars in solutions for these motions. Their mean parallax and mean absolute magnitude is, approximately,

$$\pi_m = 0''.0014 \qquad \text{Abs. } M = -1.4$$

For the stars of Class Md, including a few of Class Mc which are known to be variables,

$$\pi_m = 0''.0022 \qquad \text{Abs. } M = -0.9$$

Solutions for the coördinates of the solar motion, excluding the stars of Class N give,

A	D	M	No.	Class
277°	+42°	0″.0202	156	Mc, Md
269	+44	.0088	34	R
274	+38	.0165	219	All

Solutions for the preferential motions of the 219 stars give,

$A_1 = 98°$	$D_1 = +12°$	$\lambda_1 = 14''.33$
$A_2 = 352$	$D_2 = +53$	$\lambda_2 = 7.69$
$A_3 = 196$	$D_3 = +34$	$\lambda_3 = 5.57$

indicating that these stars follow in their motions the general tendencies of the stars of other types in preferential motion towards

Kapteyn's vertex, the velocity ellipsoid being flattened toward the plane of the Milky Way.

REPORT OF COMMITTEE

REPORT OF THE ECLIPSE COMMITTEE, MARCH 1923.

The total solar eclipse of September 10, 1923, will be observable, under very promising conditions, from the vicinities of Lompoc and San Diego, California, from the large islands lying southerly from Santa Barbara and westerly from San Diego, and from Lower California, Mexico, and under less promising conditions from the mainland of Mexico and in Yucatan. Lompoc and San Diego are well within the north-eastern edge of the shadow path. The central line of the shadow passes about midway between Santa Rosa Island and San Nicolas Island; San Clemente Island lies exactly on the central line; Ensenada, Lower California, is only four or five miles north-easterly from the central line; the central line lies about midway between Hermosillo and Guaymas; Cuencame, in Durango, Mexico, is about fifteen miles north-east of the central line; Tampico is possibly twenty miles north-east of the central line; and Payo Obispo, on the east coast of Yucatan, is very close to the central line. San Diego and Santa Catalina Island are about equally distant from the central line. The north-eastern edge of the shadow path lies very close to Santa Barbara and Oceanside.

The duration of totality, at points on the central line westerly from San Diego, will be about three minutes, thirty-six seconds; on the central line south of Tampico, about two minutes, fifty-three seconds; and at Payo Obispo, about two minutes, twenty-five seconds.

The first table is a resumé of weather observations secured at the request of the Committee at eleven points in Southern California and Lower California; the data of the table rest upon observations made on the first twenty days of September, by the following observers, to whom our acknowledgments and thanks are due:

Mr. Geo. A. Dickson, Principal, Oceanside and Carlsbad Union High School, Oceanside.
Mr. C. Fallen, Keeper of the Lighthouse, Point Conception.
Mr. T. M. Polhamus, City Treasurer, and Local Manager Santa Catalina Island Company, Avalon.
Mr. H. B. Hersey, Meteorologist, U. S. Weather Bureau, Los Angeles.
Mr. H. F. Alciatore, Meteorologist, U. S. Weather Bureau, San Diego, in September, 1921.
Mr. Dean Blake, Meteorologist, U. S. Weather Bureau, San Diego, in September, 1922.
Miss Lillian P. Williams, Principal, Union High School, Lompoc.
Mr. T. S. Cordill, Special Observer, Port McArthur, San Pedro.
Mr. Anton Deraga, Newport Harbor.
Dr. W. J. Luyten, Martin Kellogg Fellow in the Lick Observatory, San Clemente Island.
Mr. W. D. Madden, British Vice-Consul, observing station 6 miles southeasterly from Ensenada, Lower California.

METEOROLOGICAL OBSERVATIONS, 1 P. M., SEPTEMBER 1-20, 1921 AND 1922.

		No. of Days							No. of Days			No. of Days			
		No. of days	Clear	Clouds near horizon	Scattered clouds 1-3	Scattered clouds 4-7	Scattered clouds 8-10		Fog overhead	Fog over ocean		Mild wind	Medium wind	Heavy wind	Direction of wind
Avalon	1922	20	10	4	6	0	0	Clouds thin	1	—		20	0	0	Not given
Balboa	1921	19	8	6	5	0	0	Clouds thin	0	1		20	0	0	S to W
Newport Harbor	1922	20	12	0	1	2	5	Thick clouds 5 days	1	1		20	0	0	S to W
Lompoc	1921	20	10	1	1	3	4	Thick clouds 4 days	3	—		8	3	1	Not given
Los Angeles	1921	20	13	1	3	3	0	Clouds thin	0	—	Haze and smoke	20	0	0	SW and W
	1922	20	15	0	3	2	0	Thin. Max. clds. 5	0	—	near horizon	20	0	0	SW and W
Oceanside	1921	20	14	6	0	0	0	Max. cloudiness 1½	0	3	Haze near horizon	13	7	0	W and SW
	1922	20	10	0	6	0	4	Location and thickness not given	3	4	Catalina and San Clemente invisible	10	5	5	W and SW
Pt. Conception	1921	20	3	4	3	4	6		1	9		10	6	4	NW and SE, heavy wind from NW
	1922	20	0	2	9	4	5		5	13		7	5	8	NW and SE
San Clemente	1922	9	4	1	0	0	4		3	—		6	1	0	W
San Diego	1921	20	13	4	1	2	0	Clouds thin	0	0		16	4	0	NW to SW
	1922	20	0	13	1	4	2	Thick clouds 3 days	0	6		17	3	0	NW to SW
Br. Consulate, Ensenada, L. C.	1922	20	8	0	5*	6	1	Character of clouds not usually given	0	3	Light fog	14	1	0	W
San Pedro	1921	19	10	6	2	0	1	Clouds thick 1 day	1	14		9	6	0	SW
	1922	20	16	2	1	0	1	Thick clouds 2 days	1	17		1	3	16	SW to W

* "mostly in the south and east and at the extreme points of the area under observation."

The observations by Consul Madden were made at 1:15 P. M., Pacific Standard Time, and all the others at 1 P. M., these being the approximate times at which the total solar eclipse will occur on September 10.

Three years ago the Weather Service of the Mexican National Government was requested to secure weather observations in or immediately adjoining the path of total eclipse, making them at the hour of the day when the eclipse at each point will be total. This service was generously undertaken by Senor Sanchez, in charge of the Bureau. Professor Joaquin Gallo, Director of the National Observatory at Tacubaya, coöperated in forming the programme. Professor Gallo has recently supplied the Committee with the results as quoted in the second table.

The mean cloudiness at the eclipse hour for the first twenty days in September is expressed in percentages in the first column, and for the five days, September 8 to September 12 inclusive, in the second column. The number of years covered by the observations, in each case, is given in the third column.

	Date 1-20 Percent	Date 8-12 Percent	Years
Ensenada, Lower California	35	35	3
Tiajuana, Lower California	5	0	2
Hermosillo, Son.	40	10	1
Guaymas, Son.	30	50	2
Choix, Son.	35	50	2
Ortiz, Son.	30	10	1
Tepehuanes, Dgo.	95	100	4
Cuencame, Dgo.	4	0	3
Santiago Papasquiaro, Dgo.	40	30	1
Matehuala, S. L. P.	50	80	1
Charcas, S. L. P.	60	40	2
Catorce, S. L. P.	35	40	2
Cerritos, S. L. P.	60	50	1
Ozoluama, Ver.	40	40	1
Ebano, Tamps.	50	60	1
Tampico, Tamps.	50	50	25
Champoton, Cam.	67	65	4
Campeche, Cam.	70	70	1
Payo Obispo, Q. Roo.	70	80	3

The observations and experiences of Mr. Campbell's party in Lower California in 1921 have been described in *Publications Astronomical Society of the Pacific*, **33**, pp. 255-257. Except that very thin clouds covered fifty per cent of the sky at the eclipse hour at Tiajuana on September 2nd, no clouds whatsoever existed by day or by night during the interval of nine days. The sky was not only continuously clear, but very blue, and the winds were light. On the three nights when the party was in Ensenada, the ocean fogs covered the region during the latter half of the nights and the early hours of the forenoons, but the sky was entirely clear after 9 A. M.

The official weather report for Tiajuana for the years 1921 and 1922 is in good accord with the general conditions observed by Mr.

Campbell's party in 1921. The conditions near Ensenada in 1922 seem not to have been so favorable as those in 1921.

The results for Cuencame are strikingly more promising than those reported for neighboring stations. Professor Gallo recently visited Cuencame and his inquiries elicited the information that the Septembers of the past three years have been remarkable for their dryness. It would appear that local conditions have controlled the cloudiness and rainfall. It is doubtful, however, whether an inquiring observer should regard the conditions to be expected in September, 1923, as more promising than those at the adjacent stations, which in past years have reported a high percentage of cloudiness.

It should be held in mind that the wet season on the mainland of Mexico comes in the summer months, and the summer rains are not due to be over until later than September 10th. The records show that rain frequently falls in the Guaymas and Hermosillo region and in the Gulf of California as late as September, and in some years the rains cover the eastern part of the peninsula of Lower California.

The month of September in Southern California and in the western half of the peninsula of Lower California is probably as favorable as any month of the year. Rainfall is not expected on any one of its days. The days completely clouded should be few, and the eclipse hour, 1 P. M., is favorable as to absence of ocean fogs. Eclipse observers should probably expect that ocean fogs covering the night sky will interfere somewhat with the adjusting of instruments by means of stellar observations. Such adjustments should not be delayed until the nights immediately preceding the eclipse date. The data in the first table above should give considerable confidence to prospective eclipse observers, but a clear sky at 1 P. M. on September 10th ought not to be regarded as a certainty.

The conditions observed at Lompoc and Point Conception in the past two Septembers suggest that these points are not so promising as those situated south and south-easterly therefrom.

San Clemente Island is easily accessible from the mainland. The island is devoted to sheep grazing and is under lease to the San Clemente Sheep company, Mr. E. G. Blair, President, 515 East Fifth Street, Long Beach, California. A small motor launch belonging to the Company makes frequent trips from San Pedro to the island. A landing at Wilson's Cove, on the north-east shore, where a pier extends out to deep water, is usually made with ease. The ranch buildings are at this point. An expedition situated anywhere on the island would be obliged to provide its own living arrangements. Fresh water is scarce, and dependence appears to be placed upon rain water in storage. It is not certain that labor would be available, except by special arrangement. Astronomers who are considering a location on the island should make known their plans to Captain H. W. Rhodes, Superintendent of Lighthouse, U. S. Custom House, San Francisco,

who is interested in the subject and who has expressed his readiness to assist in arranging for transportation and other necessary items. The Chairman of this Committee arranged with Dr. W. J. Luyten, member of the Lick Observatory staff (now of the Harvard College Observatory), to survey the conditions on San Clemente Island in the period September 4 to September 12, 1922. His report is not wholly favorable as to atmospheric conditions. On a few days the sky was overcast at the eclipse hour, and at other times the sky was not noted for blueness. The wind was fairly strong on several days, and the ocean fog covered the island on several evenings and nights. The making of adjustments by night would have been difficult.

All points on the mainland of California, and Avalon, the very attractive port and city of Santa Catalina Island, are easily accessible. Ordinary supplies and labor are at hand, and comfortable living accommodations should be found without difficulty.

Avalon is a very popular resort for tourists, and the number of people on the island at the time of the eclipse will doubtless be very large.

Mr. P. V. Reyes, photographer at Avalon, desires us to say that he will be glad to arrange for dark-room facilities for eclipse observers.

Mr. J. H. Beesley, Box 1301, Avalon, Manager of the Country Club, would be pleased to arrange for space for observers on the grounds of the Club, about one-fourth mile from the center of the town, in a sheltered position, altitude about 100 feet. The wireless station, slightly more than one mile south of Avalon, with open flat space at sea level, might offer advantages as an observing station.

Middle Ranch, altitude about 800 feet, and approximately ten miles from Avalon, can be reached by a narrow and steep road.

The conditions on the other large islands situated southerly from Santa Barbara are probably not very different from those described for San Clemente and Santa Catalina Islands, though actual observations of the conditions in the other islands have not been made.

Santa Rosa Island is owned by Vail & Vickers, Los Angeles. Santa Cruz Island is owned by Mr. A. J. Caire, 520 Mission Street, San Francisco.

Excellent observing stations can be found at many points in Lower California, but elsewhere than at Ensenada an expedition would have to be self-contained and complete as to its supplies and living arrangements. In Ensenada observers should be able to obtain rooms in some of the smaller hotels, and possibly in private residences, but the restaurants might have to be depended upon for the meals. Ordinary supplies, such as lumber, nails, etc., labor and transportation should be readily obtainable. The population of Ensenada is probably in the vicinity of two thousand.

Ensenada lies about seventy miles in a straight line south-easterly from San Diego. A small freight steamer makes irregular trips be-

tween San Diego and Ensenada, often at one-week intervals and again at fortnightly intervals. The freight rate is $7 per ton of forty cubic feet. Landing from the steamer at Ensenada is by small cargo boats. The landing area is well protected from ocean winds, and there should be no difficulties in this connection.

A passenger and mail stage runs between San Diego and Ensenada on three round trips per week. The distance is about eighty-six miles by the "coast highway," and the stage fare in each direction is $8. The highway is excellent over three-quarters or four-fifths of its length. but the central section of it during the present winter months is not in good condition. In the summer months of August and September the road should give no anxiety.

The governmental conditions in Lower California are excellent, and eclipse observers would find a warm welcome, and sympathy with their purpose.

Mr. Campbell's party, in September, 1921, travelled by automobile twenty-one miles east-south-easterly from Ensenada, following up the canyon of the Santa Clara River to the beginning of La Grulla Valley. They should have gone nine miles farther in order to reach the intersecting point of the eclipse axis with the river and road. The conditions in the valley appeared to be excellent. La Grulla is protected from the ocean fogs and wind by intervening ranges of hills. Water is fairly plentiful, and some assistance in the way of labor could probably be obtained. The local conditions at the intersecting point are under survey at the present time by Messrs. Masten and Hillyer of San Diego. It is not expected that there will be any difficulty of transport between Ensenada and La Grulla Valley, though sections of the road are in the creek bed, and the sand will limit the size of loads. Perishable foods are obtainable in limited variety in Ensenada.

His Excellency, the Governor of Lower California, Senor Don Jose I. Lugo, residing at Mexicali, is undertaking to secure the approval of the General Government of Mexico for the free entry of eclipse instruments and eclipse supplies at the port of Ensenada, and at Tiajuana. Tiajuana is about eighteen miles south-easterly from San Diego and is the first Mexican village through which the stage passes.

Expeditions coming to the United States from other nations will be interested in the regulations of the Treasury Department of the United States concerning the admission of their equipment. We are indebted to the Chief of the Division of Customs for the following information on this subject. Paragraph 1705 of the Tariff Act of 1922 provides for the free entry of philosophical and scientific apparatus brought by professional scientists arriving from abroad for use by them temporarily in the promotion and encouragement of the arts, sciences or industry in the United States, and not for sale. It is required that bonds be given for the payment of duty on such articles as shall not be

exported within six months from the date of importation. The Treasury Department has held that under this provision instruments may be brought in for observational purposes, and a liberal interpretation is given to the term philosophical and scientific apparatus. If intending observers will keep the Chairman of this Committee informed as to the port and approximate date of entry he will be pleased to advise as to procedure; but the better plan would seem to be that any foreign astronomer, before leaving his home port, should secure from his export agent the address of the American importing broker whom he will ask to attend to all the formalities of the entry.

Respectfully submitted,

W. W. CAMPBELL, *Chairman*,
HEBER D. CURTIS
JOAQUIN GALLO
W. J. HUMPHREYS
FRANK B. LITTELL
S. A. MITCHELL
Eclipse Committee.

PLANETARY OCCULTATIONS IN 1923.

L. J. COMRIE.

Predictions for the earth generally of all occultations of stars by planets in the year 1923 have been communicated to the *Journal of the British Astronomical Association*, Vol. XXXIII, No. 4. This note is a resumé of the predictions in so far as observers in the U. S. A. are concerned; for the complete details the original paper must be referred to. No occultations by Venus, Mars, Saturn, Uranus or Neptune can be favorably observed in this year. Three stars of the 9th, 8th and 7th magnitude respectively are occulted by Jupiter as follows:

(1) 1923 April 2. Star B. D. $-15°4027$. B. D. magnitudue 9.1, Harvard 9.7. The immersion is visible throughout U. S. A. and the emersion from the western states. In longitude 6^h west and latitude 40° north the immersion occurs at $20^h\ 19^m$ G. M. T.; for points to the east of this the star will disappear one or two minutes earlier and vice versa. The approximate time of emersion is $22^h\ 56^m$. The position angle of the point of disappearance, measured from the north point of Jupiter, is 325°; measured from the north pole of the planet it is 308°. The corresponding angles at reappearance are 70° and 53°. The altitudes of the star and planet at the times mentioned are given below.

Observatory	Immersion	Observatory	Immersion
Harvard	28°	Washington	33°
Yale	30	Allegheny	32
Sproul	32	Cincinnati	34
McCormick	34	Yerkes	31

Observatory	Immersion	Emersion
Flagstaff	36°	35°
Mt. Wilson	35	38
Lick	31	36

(2) 1923 April 28. Star B. D. —14°4069 or W. B. 14^h 891. B. D. magnitude 8.5, Harvard 8.3. This occultation becomes practically a graze as seen from the eastern part of U. S. A., so that no prediction can be given, except for the time of closest approach, or the centre of the occultation, which occurs about 16^h 9^m G. M. T. The star passes the north pole of Jupiter, and should be watched from 15^h 30^m onwards.

Observatory	Altitude	Observatory	Altitude
Harvard	31°	Washington	33°
Yale	31	Allegheny	30
Albany	30	Cincinnati	30
Sproul	32	Yerkes	25
McCormick	33		

(3) 1923 May 7. Star B. D. —14°4045 or W. B. 14^h 803. B. D. magnitude 7.5, Harvard 7.1. The emersion only is visible from the eastern part of U. S. A., at about 14^h 26^m G. M. T. The position angle from the north point is 112°, which is just 4° south of the eastern end of the Jovian equator. The planet is lower than in the previous cases, as will be seen from the following table.

Observatory	Altitude	Observatory	Altitude
Harvard	26°	Washington	26°
Yale	26	McCormick	26
Albany	25	Allegheny	23
Sproul	26	Cincinnati	22

The reappearance of Satellites I and II from eclipse may be seen later in the same evening.

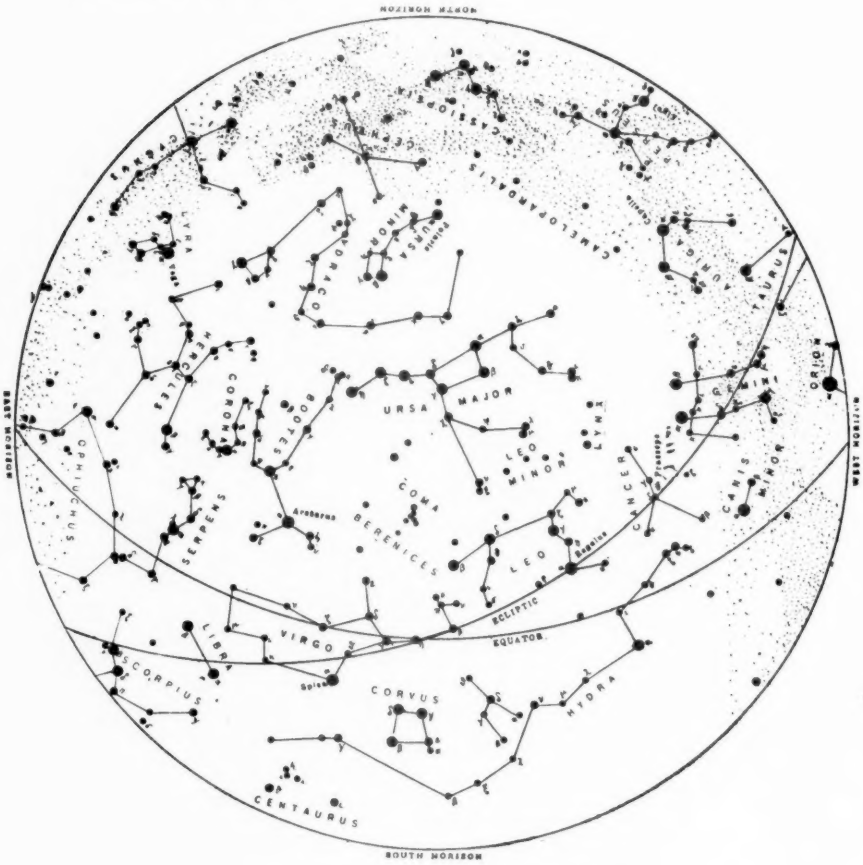
None of these stars are occulted by the satellites of Jupiter. It must be remembered that small unavoidable errors in the assumed positions of the stars or in the ephemeris of the planet create uncertainties of several minutes in the predictions. The observer should therefore be on the watch some 5 or 10 minutes before the times given. Users of small telescopes (less than 6-inch) are warned that it may be difficult to see these faint stars when in contact with the limb of Jupiter, although good observations could probably be made with larger instruments.

In 1924 there are no occultations by Saturn, and only two of 9th magnitude stars by Jupiter, both visible from South America and New Zealand.

Sproul Observatory, Swarthmore, Pa.

PLANET NOTES FOR MAY.

The *sun* will continue its motion northeastward and will move from the constellation Aries into the constellation Taurus. About the middle of the month it will pass the Pleiades, and at the end of the month it will be very near the bright star Aldebaran.



THE CONSTELLATIONS AT 9:00 P. M. MAY 1.

The phases of the *moon* will occur as follows:

Last Quarter	May 7 at 12 M.	C. S. T.
New Moon	15 " 5 P. M.	"
First Quarter	23 " 8 A. M.	"
Full Moon	29 " 11 P. M.	"

The *moon* will be nearest the earth for the month on May 28, and farthest from the earth on May 12.

Mercury will be at greatest elongation east on May 5. On this date it will set about one hour and a half after the sun, and will be a short distance north of the star Aldebaran. It will be a favorable time for those who have never seen this planet to watch for it just after sunset on and near this date. It will then move toward the sun again and soon become invisible. It will pass the sun on May 28.

Venus will still be the brilliant morning star but will be several degrees south of the sun and consequently will be low in the southeast at sunrise. It will be approaching the sun slowly.

Mars will be too near the sun for observation during this month and the few succeeding months.

Jupiter will be in opposition on May 5. This means that on this day it will rise at sunset, and on succeeding days it will rise before sunset. It will therefore be well situated for observation late in the evening during the month. It will still be nearly fifteen degrees south of the equator.

Saturn will be a short distance to the northwest of Jupiter. It will, therefore, be even more favorably situated than Jupiter during May.

Uranus will come to the meridian between seven and eight o'clock in the morning. It will therefore be observable only before sunrise this month.

Neptune will be in quadrature, 90° east of the sun, on May 6. It will be on the meridian at sunset, and will be well situated in the early evening throughout the month.

Occultations Visible at Washington.

[*From the American Ephemeris.*]

Date 1923	Star's Name	Magnitude	IMMERSION. Washington M.T.	IMMERSION. Angle from N	EMERSION. Washington M.T.	EMERSION. Angle from N	Duration
			h m	°	h m	°	h m
May 1	49 Librae	5.4	12 18	114	13 35	278	1 18
2	90 B. Ophiuchi	6.5	10 53	87	12 1	299	1 8
4	187 B. Sagittarii	6.4	14 58	85	16 24	266	1 25
6	96 B. Capricorni	5.9	16 52	9	17 30	318	0 38
9	96 Aquarii	5.7	13 36	86	14 36	242	0 59
19	110 B.Gemin.	6.2	6 54	70	7 52	312	0 58
23	37 Sextantis	6.3	11 46	76	12 32	324	0 47

Daylight Occultation of Aldebaran.—This will occur on the afternoon of April 19. Maps have not been drawn for it, because it cannot be observed except with a good telscope and in a clear sky. Those wishing to try their skill may be guided somewhat by the phases at Washington and Omaha. The times are Central. The moon will be 3.5 days old, only about 50° away from the sun.

	Immersion			Emersion		
	h m	°	°	h m	°	°
Washington	4 22,	S 79 E,	T 52 L	5 39,	S 70 W,	B 16 R
Omaha	3 40,	N 86 E,	T 72 L	5 09,	S 78 W,	B 38 R

WILLIAM F. RIGGE.

COMET NOTES.

Comet Medals.— The Donohoe Comet Medal of the Astronomical Society of the Pacific has been awarded to

1. Mr. Wm. Reid, of Rondebosch, South Africa, for the discovery of comet *a* 1922 on January 20,

2. Mr. F. J. Skjellerup, of Cape Town, South Africa, and Mr. Wm. Reid, of Rondebosch, for the independent discovery of comet *b* 1922 on May 16,

3. Dr. W. Baade, of Hamburg-Bergedorf, Germany, for the discovery of comet *c* 1922 on October 19,

4. Mr. F. J. Skjellerup, of Cape Town, South Africa, for the discovery of comet *d* 1922 on November 25.

A fifth comet, supposed to be Perrine's periodic comet was discovered by Professor S. Hirayama, of Tokyo, Japan, on November 29. No other observations have been made of it, so far as we know.

VARIABLE STARS.

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard time 6h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1923							
					May							
	h m	° ′		d h	d h		d h		d h		d h	
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7	3 18							
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	5 20		14 0		22 3		30 6	
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	7 2		14 20		22 14		30 7	
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	4 22				19 17			
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	5 3		13 2		21 0		28 23	
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	5 0		12 19		20 14		28 9	
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0			8 22		25 7			
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	2 17		11 7		19 20		28 11	
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1			10 21		22 0			
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	7 9		19 0		30 15			
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	4 7		11 23		19 15		27 6	
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3			10 18		20 21		31 0	
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	8 14		16 7		24 0		31 3	
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	4 4		15 5		20 18		31 19	
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	8 12		16 2		23 15		31 5	
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	4 8						31 8	
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	8 11		15 21		23 8		30 19	
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	1 8		9 6		17 4		25 2	
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	3 20		13 23		24 3			
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	3 20				26 2			
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	5 9		13 8		21 6		29 6	
V Carinæ	8 26.7	—59 47	7.4— 8.1	6 16.7	2 23		9 15		23 1		29 17	
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	5 0		9 15		18 22		28 4	

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1923							
					May							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	4 21	13 15	22 9	31 3				
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 00.0								
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	4 6	11 1	17 20	24 15				
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	5 10	12 0	25 5	31 20				
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	6 16	16 8	25 23					
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	9 15	17 14	25 14	28 10				
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	4 13	11 7	24 18	31 14				
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	3 8	9 4	20 19	26 15				
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	3 18	13 3	17 20	27 5				
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5		14 12	31 18					
SS Hydræ	25.0	−23 08	7.4— 8.1	8 04.8	5 5	13 10	21 15	29 20				
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	8 8	15 8	22 9	29 10				
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	3 13	11 18	20 0	28 5				
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	1 3	6 15	17 15	28 14				
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	1 16	9 5	24 8	31 21				
R Triang.Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	2 8	9 3	22 16	29 11				
S Triang.Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	6 23	13 6	19 14	25 22				
S Normæ	16 10.6	−57 39	6.6— 7.6	9 18.1	3 9	13 3	22 21					
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	6 9	15 6	24 3	28 13				
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	3 10	9 12	21 15	27 16				
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	6 8	13 8	20 8	27 9				
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9		15 1						
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	4 18	12 8	19 22	27 12				
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	6 7	12 1	23 15	29 9				
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	1 12	8 6	21 18	28 11				
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	9 20	20 14	30 12					
RZ Lyræ	18 39.9	+32 42	9.9—11.2	0 12.3	2 13	8 16	20 23	27 2				
RT Scuti	18 44.1	−10 30	9.1— 9.7	0 11.9	5 22	11 21	23 18	29 17				
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	8 8	17 10	26 12					
U Aquilæ	19 24.0	− 7 15	6.2— 6.9	7 00.6	3 19	10 19	24 20	31 21				
XZ Cygni	19 30.4	+56 10	8.6— 9.3	0 11.2	6 21	13 21	20 21	27 21				
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	4 21	12 20	20 20	28 19				
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	7 16	15 8	23 1	30 18				
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	6 12	13 17	20 21	28 1				
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	2 3	10 12	18 21	27 6				
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	2 23	9 6	21 21	28 5				
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	4 19		21 3					
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	1 13	10 10	19 6	28 4				
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	3 23	10 17	24 4	30 21				
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	4 9	11 2	24 12	31 5				
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	1 18	16 11	31 4					
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	6 11	14 8	22 4	30 1				
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	6 18	13 15	20 12	27 10				
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	5 11	15 5	20 2	29 19				
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	1 13	10 5	18 20	27 12				
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	5 6	10 15	21 9	26 17				
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1		10 18	21 16					
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	4 9	10 19	23 15	30 1				
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	3 19	8 18	18 18	28 17				
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	5 8	10 19	21 16	27 3				
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	2 23	13 20	19 7	30 4				
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	1 7	7 15	20 5	26 12				
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	3 17	15 20	28 0					
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	2 2	9 2	23 1	30 0				

Minima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1923							
					May							
	h m	° ′		d h	d h		d h		d h		d h	
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8					16 8			
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	3 6		10 22		18 14		26 6	
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	8 3		15 15		23 3		30 14	
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	6 20		12 23		25 4		31 7	
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	7 8		15 21		24 11		30 4	
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	7 15		14 12		21 8		28 5	
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	6 20		14 0		21 4		28 8	
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	2 15		11 10		20 5		29 0	
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	8 16		16 14		24 13			
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6			14 2					
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	5 22		14 13		23 3		31 18	
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	2 13		9 8		22 23		29 18	
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	6 14		14 11		22 9		30 7	
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	7 12		15 20		24 3		29 16	
RV Persei	4 04.2	+33 59	9.5—12.0	2 23.4	7 12		15 9		23 6		31 4	
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	2 5		15 10		28 15			
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	4 8		13 18		23 5		29 12	
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1			9 9		21 20			
TT Aurigæ	5 02.8	+39 27	7.8— 8.7	0 16.0	6 12		13 4		19 20		26 12	
RY Aurigæ	11.5	+38 13	10.7—11.7	2 17.5	5 5		13 10		21 14		29 18	
RZ Aurigæ	42.9	+31 40	10.6—13.3	3 00.3	6 18		12 19		24 20		30 20	
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	5 20		14 12		23 4		31 20	
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	6 8		16 18		21 23		27 4	
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	1 10		7 0		18 5		29 10	
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	6 13		12 7		23 18		29 11	
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	1 19		7 0		18 5		29 10	
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	7 13		15 18		23 23		29 10	
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	3 20		11 11		19 2		26 17	
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	9 9				21 14			
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	4 9		11 13		18 17		25 21	
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	1 20		8 6		21 22		28 17	
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	9 3		18 10		27 17			
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	5 5		12 6		18 20		25 11	
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	4 12		12 22		21 7		29 17	
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	1 10		7 17		20 16		27 3	
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	4 10		11 17		19 1		26 6	
X Carinae	8 29.1	—58 53	7.9— 8.7	0 13.0	6 21		15 0		23 3		31 6	
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	5 11		14 23		24 11			
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 6.8	3 6		10 2		23 18		30 15	
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	1 19		7 17		19 14		31 11	
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	4 9		11 2		24 14		31 8	
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	7 1		14 11		21 20		29 6	
SS Carinæ	10 54.2	—61 23	12.2—12.8	3 07.2	1 7		7 21		21 2		27 16	
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	4 4		13 0		21 19		30 14	
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	5 16		13 1		20 8		27 16	
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	6 19		13 14		20 9		27 4	
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	8 1		15 13		23 1		30 13	
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	5 18		10 13		20 4		29 18	
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	6 12		13 22		21 8		28 19	
133926 Hydræ	13 39.0	—26 23	8.6—12.7	2 21.5	1 12		13 2		18 21		30 11	

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1923							
					May							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	3 13	10 13	24 12	30 11				
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	1 22	8 20	22 16	29 13				
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.3	8 10	16 20	25 6	30 21				
SS Librae	15 43.4	—15 14	9.3—11.5	0 18.4	4 7	11 12	18 16	25 21				
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	2 3	9 11	24 4	31 12				
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	5 4	13 11	21 17	29 23				
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	8 1	16 21	25 17	30 3				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1		9 10	30 4					
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	2 13	9 8	22 23	29 18				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	6 20	15 6	23 15	28 16				
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	4 18	10 21	23 4	29 8				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	4 6	10 10	22 19	28 23				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	7 14	14 23	22 7	29 16				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	3 22	12 2	20 6	28 20				
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	5 20	13 9	20 22	28 11				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	5 17	13 11	21 4	28 22				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	3 11	11 11	19 11	27 10				
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	1 9	9 21	18 10	26 22				
WY Sagittarii	17 54.9	—23 1	9.5—10.6	4 16.0	5 1	14 9	23 17	28 9				
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	7 17	18 2	28 10					
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	3 6	10 12	17 18	25 0				
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	7 6	14 3	21 1	27 23				
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2	3 11		18 14					
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	1 18	8 23	23 6	30 10				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	3 0	10 2	24 8	31 11				
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	7 19	16 2	24 10	28 13				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	1 1	9 13	18 1	26 12				
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	2 19	9 11	22 18	29 9				
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8	1 19	14 17	27 15					
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	5 11	13 2	20 18	28 9				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	1 15	9 5	24 9	31 22				
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	7 8	14 12	21 17	28 22				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	8 13	17 12	26 11	30 22				
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	3 10	10 4	23 17	30 11				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	1 6	8 15	23 9	30 17				
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	2 0	10 12	21 0	31 1				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	6 13	13 1	19 14	26 3				
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	4 21	10 21	22 22	28 22				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	7 1	13 17	20 8	26 23				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	4 1	13 4	22 8	31 11				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	8 3	16 13	25 0					
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	4 12	11 7	24 20	31 15				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	2 3	8 1	21 20	28 17				
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0		13 17						
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	6 19	16 9	26 1	30 20				
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	1 21	11 2	20 6	29 11				
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	8 2	17 2	26 2	29 2				
WZ Cygni	48.3	+38 27	9.9—10.8	0 14.0	1 1	8 15	23 20	31 10				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	5 18	15 21	26 0	31 1				
RY Aquarii	14.8	—11 14	8.8—10.4	1 23.2	8 17	16 14	24 11	28 9				
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	3 10	13 13	23 17	28 19				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3				29 23				
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	1 13	11 22	17 3	27 11				
VW Pegasi	51.7	+32 41	10.0—10.6	5 06.4	1 19	12 8	17 14	28 3				
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.3	8 12	16 1	23 13	31 2				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	7 17	15 23	24 5	28 8				

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December 0 = J. D. 2423389 January 0 = J. D. 2423420
February 0 = J. D. 2423451

001046 X Andromedae—
3434.6 11.7 Lv, 3449.6 12.0 Lv,
3436.6 11.7 B, 3458.7 12.0 Wf,
3440.7 11.7 Wf, 3464.6 12.6 Lv.
3441.6 11.8 Lv,

001620 T Ceti—
3385.9 5.7 Kd, 3416.9 5.7 Kd,
3390.9 5.6 Kd, 3418.9 5.6 Kd,
3393.9 5.8 Kd, 3422.9 5.8 Kd,
3395.9 5.7 Kd, 3424.9 5.7 Kd,
3401.3 5.3 An, 3425.9 5.8 Kd,
3402.9 5.7 Kd, 3431.9 5.8 Kd,
3403.3 5.0 L, 3434.2 5.4 An,
3405.9 5.8 Kd, 3437.2 5.4 L,
3409.9 5.6 Kd, 3437.3 5.3 An,
3412.9 5.7 Kd. 3437.9 5.7 Kd.

001726 T Andromedae—
3409.5 13.5 Pt, 3456.6 14.1 Pt.
3441.6 13.7 Lv.

001755 T Cassiopeiae—
3400.2 11.9 L. 3438.3 11.7 L,
3409.5 12.0 Pt, 3446.3 11.4 L,
3414.6 11.4 B, 3456.6 12.1 Pt,

001838 R Andromedae—
3409.6 13.3 Pt, 3450.5 9.4 Cu,
3418.6 [13.4 B, 3456.5 9.5 Cd,
3426.9 13.6 Kd, 3456.5 9.3 Cu,
3440.7 10.3 Wf, 3456.6 9.1 Pt.
3442.5 10.1 Cu, 3458.5 9.4 Cd,
3447.5 9.5 Cu. 3458.7 9.1 Wf,
3447.5 9.6 Cd, 3461.6 8.8 Ya.

001909 S Ceti—
3411.7 8.0 Sg, 3447.5 9.0 Cu,
3427.7 8.1 Sg, 3456.5 9.6 Cu,
3442.5 8.4 Cu, 3456.5 9.2 Pt.
3445.7 8.8 Pt.

002546 T Phoenicis—
3363.0 9.7 Bl, 3393.0 11.4 Bl.
3374.0 10.3 Bl, 3402.0 12.5 Bl.
3383.0 11.0 Bl.

002833 W Sculptoris—
3370.0 13.0 Bl, 3396.0 13.0 Bl.

003179 Y Cephei—
3442.6 11.8 Br, 3456.6 9.8 Br.

004047 U Cassiopeiae—
3409.6 14.0 Pt. 3440.7 [14.0 Wf.

004132a RW Andromedae—
3440.7 [13.7 Wf.

004435 V Andromedae—
3418.6 9.0 B, 3449.6 10.0 Lv,
3434.7 9.6 Lv. 3464.6 10.8 Lv.
3442.6 9.6 Lv,

004435 X Sculptoris—
3363.0 10.2 Bl, 3393.0 10.9 Bl,
3374.0 10.6 Bl, 3402.0 10.5 Bl,
3383.0 10.4 Bl, 3417.0 11.3 Bl.

004533 RR Andromedae—
3436.6 9.7 B, 3458.7 10.4 Wf.
3440.7 9.7 Wf,

004746a RV Cassiopeiae—
3400.2 9.8 L, 3446.3 9.4 L,
3409.6 9.0 Pt, 3456.6 10.0 Pt,
3438.3 9.5 L, 3458.7 10.3 Wf.
3440.7 9.6 Wf,

004958 W Cassiopeiae—
3401.5 10.2 Gi, 3430.6 10.3 Ya,
3409.6 11.1 Pt, 3437.5 9.8 Gi,
3414.6 9.8 B, 3456.6 9.4 Pt,
3423.9 11.5 Ys, 3461.6 10.0 Ya,

005475 U Tucanae—
3363.0 12.6 Bl, 3399.0 14.0 Bl.

010102 Z Ceti—
3407.6 12.6 B, 3439.5 13.2 B.
3409.6 12.4 Pt.

010630 U Sculptoris—
3363.0 12.0 Bl, 3393.0 9.8 Bl,
3370.0 11.5 Bl, 3402.0 9.9 Bl,
3383.0 9.9 Bl, 3417.0 10.1 Bl.

010940 U Andromedae—
3427.7 [12.6 Br, 3440.7 13.8 Wf,
3436.6 [13.1 B, 3458.7 13.6 Wf.

011041 UZ Andromedae—
3440.7 13.1 Wf, 3458.7 11.0 Wf.

011208 S Piscium—
3436.6 [13.6 B.

011272 S Cassiopeiae—
3410.6 13.8 Lv, 3442.6 13.9 Lv,
3440.7 [14.5 Wf, 3458.7 14.3 Wf.

011712 U Piscium—
3409.6 13.5 Pt, 3456.6 12.2 Pt.

012233 R Sculptoris—
3402.0 6.4 Kd, 3420.9 6.7 Kd,
3407.9 6.7 Kd, 3422.9 6.8 Kd,
3412.9 6.9 Kd. 3425.9 6.8 Kd.

012350 RZ Persei—
3436.6 10.2 B, 3458.5 10.5 Y.

012502 R Piscium—
3437.5 [13.1 Y.

013238 RU Andromedae—
3375.0 10.4 Ch, 3439.6 9.8 B,
3402.2 11.4 Ch, 3440.7 12.8 Wf,
3427.6 12.6 Br, 3456.6 13.2 Pt.
3435.6 13.4 Pt, 3458.7 13.0 Wf.

VARIABLE STAR OBSERVATIONS, December 20, 1922 to February 20, 1923—Continued

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
013338 Y ANDROMEDAE—				
	3375.0	[11.0 Ch,	3435.6	9.6 Pt,
	3402.2	11.6 Ch,	3456.6	9.5 Pt.
	3433.6	9.7 Br,		
014958 X CASSIOPEIAE—				
	3435.5	12.0 Pt,	3456.6	12.0 Pt,
	3436.6	11.6 B,	3461.5	11.3 Y.
015354 U PERSEI—				
	3409.7	8.0 Sg,	3436.7	8.0 Sg,
	3428.7	8.0 Sg,	3456.6	8.2 Pt,
	3435.6	7.9 Pt,	3456.7	8.5 Sg,
	3436.0	8.0 Ys,	3461.6	8.3 Ya.
	3436.7	8.3 B,		
015912 S ARIETIS—				
	3435.6	13.8 Pt.		
021024 R ARIETIS—				
	3390.3	8.4 L,	3438.4	12.9 Gi,
	3433.6	12.0 Br,	3443.6	12.8 Wf,
	3435.6	12.1 Pt,	3444.3	13.0 L,
	3436.6	11.9 B,	3456.6	13.0 Pt,
	3437.3	12.1 L,	3458.7	13.7 Wf.
021143a W ANDROMEDAE—				
	3435.6	9.9 Pt,	3443.6	9.3 Wf,
	3438.5	9.9 Gi,	3456.6	11.0 Pt,
	3442.6	10.0 Br,	3458.7	10.8 Wf.
021281 Z CEPHEI—				
	3415.5	[13.2 B,	3458.7	11.0 Wf,
	3443.6	11.1 Wf,	3459.6	11.4 Br.
	3444.6	11.5 Br,		
021403 o CETI—				
	3366.2	8.5 Ch,	3438.2	6.7 An,
	3386.2	8.5 Ch,	3442.3	5.8 An,
	3390.3	8.0 L,	3442.5	5.9 Cu,
	3396.1	8.4 Ch,	3444.3	5.4 L,
	3407.7	7.8 Sg,	3447.5	4.8 Cu,
	3407.8	8.1 Jb,	3450.5	4.8 Cu,
	3408.6	8.3 Ya,	3454.7	4.2 Sg,
	3414.7	7.7 Jb,	3456.5	3.8 Cu,
	3414.9	8.0 Ys,	3456.6	4.3 Pt,
	3419.1	7.7 Ch,	3456.7	4.0 Sg,
	3423.9	7.9 Ys,	3457.7	3.8 Sg,
	3427.7	7.5 Sg,	3458.5	3.8 Cu,
	3434.3	7.2 An,	3459.7	3.7 Sg,
	3435.6	6.9 Pt,	3463.7	3.5 Sg,
	3437.2	6.0 L,	3464.7	3.6 Sg,
	3437.3	6.9 An,	3468.5	3.4 Cu.
021558 S PERSEI—				
	3433.0	11.2 Ys,	3456.6	11.0 Pt.
	3435.6	10.8 Pt,		
022000 R CETI—				
	3393.9	9.6 Kd,	3413.9	10.9 Kd,
	3402.0	9.9 Kd,	3430.0	11.5 Kd.
022150 RR PERSEI—				
	3435.6	13.8 Pt,	3456.6	11.3 Pt,
	3439.6	12.2 Y,	3458.6	10.4 Y,
	3443.6	12.8 Wf,	3458.8	11.0 Wf,
	3444.6	12.3 Br,		
022426 R FORNACIS—				
	3363.0	9.3 Bl,	3393.0	9.5 Bl,
	3374.0	9.4 Bl,	3402.0	10.3 Bl,
	3383.0	9.4 Bl,	3417.0	10.1 Bl.
022813 U CETI—				
	3366.2	7.3 Ch,	3419.1	8.7 Ch,
	3380.2	7.4 Ch,	3430.0	9.3 Kd,
	3386.1	8.2 Kd,	3435.5	9.2 Pt,
	3386.2	7.5 Ch,	3439.5	9.4 Y,
	3396.1	8.1 Ch,	3440.5	9.6 B,
	3400.0	8.3 Kd,	3456.6	10.1 Pt,
	3414.5	8.6 B,	3458.6	10.0 Y.
022980 RR CEPHEI—				
	3443.6	[14.0 Wf.		
023133 R TRIANGULI—				
	3402.9	7.7 Kd,	3435.5	9.4 Pt,
	3414.0	8.5 Kd,	3442.6	10.3 Cu,
	3414.6	8.9 B,	3442.6	10.2 Ya,
	3426.9	9.6 Kd,	3449.6	10.5 Br,
	3430.0	10.2 Kd,	3456.6	10.6 Pt,
	3430.6	9.7 Ya,	3462.5	11.4 Cu.
024356 W PERSEI—				
	3342.0	10.1 Nk,	3407.7	10.5 Jb,
	3344.0	10.3 Nk,	3414.7	10.6 Jb,
	3352.0	10.2 Nk,	3430.6	10.5 Ya,
	3376.0	10.0 Nk,	3456.6	10.5 Pt,
	3386.9	10.7 Nk,	3458.5	10.4 Ya.
025050 R HOROLOGII—				
	3363.0	9.0 Bl,	3393.0	10.5 Bl,
	3374.0	10.0 Bl,	3402.0	10.8 Bl,
	3383.0	10.2 Bl,	3417.0	11.8 Bl.
025751 T HOROLOGII—				
	3370.0	13.1 Bl,	3399.0	12.9 Bl.
030514 U ARIETIS—				
	3438.4	[14.2 Gi.		
031401 X CETI—				
	3396.3	10.0 L,	3437.3	9.6 L,
	3414.0	10.0 Kd,	3440.6	9.2 Wf,
	3414.6	9.2 B,	3446.3	9.2 L,
	3415.0	9.5 Ys,	3449.7	8.7 Br,
	3427.7	9.2 Br,	3456.6	8.9 Pt,
	3430.0	9.6 Kd,	3458.7	9.0 Wf.
	3435.5	9.3 Pt,		
032043 Y PERSEI—				
	3435.5	8.2 Pt,	3458.6	8.6 Ya.
	3456.6	8.0 Pt,		
032335 R PERSEI—				
	3396.5	13.6 Gi,	3443.6	12.2 Wf,
	3432.8	12.3 Wf,	3456.6	12.7 Pt,
	3435.5	13.0 Pt,	3458.8	13.1 Wf.
	3438.4	13.7 Gi,		
035121 T ERIDANI—				
	3424.0	8.4 Kd,	3430.0	8.5 Kd.
042209 R TAURI—				
	3415.6	13.2 B.		
042215 T TAURI—				
	3407.7	10.8 Jb,	3456.6	11.2 Pt,
	3411.6	11.2 B,	3461.6	11.6 Br,
	3431.7	11.2 Sg,	3462.5	11.4 Cu.

VARIABLE STAR OBSERVATIONS, December 20, 1922 to February 20, 1923—Continued

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
042215 T TAURI—Continued.						
	3435.5	12.1	Pt,	3464.7	11.4	Sg,
	3440.7	12.0	Br,	3469.6	10.9	Cu.
	3455.7	10.0	Sg,			
043065 T CAMELOPARDALIS—						
	3435.5	13.6	Pt,	3456.6	12.4	Pt.
	3437.3	13.8	L,			
043208 RX TAURI—						
	3415.6	13.1	B,	3456.6	13.5	Pt.
	3435.5	14.2	Pt,			
043263 R RETICULI—						
	3363.0	8.3	Bl,	3393.0	10.4	Bl,
	3374.0	9.8	Bl,	3402.0	11.2	Bl,
	3383.0	10.3	Bl,	3417.0	11.8	Bl.
043274 X CAMELOPARDALIS—						
	3411.6	9.9	B,	3456.6	12.5	Pt,
	3435.5	12.0	Pt,	3461.5	12.7	Y,
	3440.7	12.5	Br,	3461.6	12.5	Br.
043562 R DORADUS—						
	3383.0	5.5	Bl,	3417.0	5.5	Bl.
043738 R CAELI—						
	3370.0	11.9	Bl,	3402.0	11.5	Bl,
	3383.0	11.6	Bl,	3417.0	11.3	Bl.
	3393.0	11.7	Bl,			
044617 V TAURI—						
	3411.6	9.9	B,	3443.6	12.2	Wf,
	3433.8	11.4	Wf,	3455.7	13.1	Wf.
	3435.5	11.2	Pt,			
045307 R ORIONIS—						
	3413.8	11.9	Br,	3440.7	12.6	Br,
	3440.6	12.9	B,	3458.6	13.	Y.
045514 R LEPORIS—						
	3366.2	8.2	Ch,	3430.6	9.7	Ya,
	3386.2	9.1	Ch,	3430.8	9.5	Pt,
	3397.1	9.3	Ch,	3438.3	9.5	L,
	3403.3	9.4	L,	3442.6	9.8	Ya,
	3409.1	9.4	Ch,	3447.4	9.8	L,
	3424.6	8.6	B,	3456.6	9.4	Pt.
050003 V ORIONIS—						
	3430.8	14.0	Pt.			
050022 T LEPORIS—						
	3363.0	11.2	Bl,	3417.0	9.0	Bl,
	3374.0	10.6	Bl,	3424.6	8.0	B,
	3383.0	10.9	Bl,	3430.8	9.0	Pt,
	3393.0	10.5	Bl,	3439.5	9.0	Ya,
	3402.0	10.0	Bl,	3456.6	9.0	Pt.
050848 S PICTORIS—						
	3363.0	8.3	Bl,	3393.0	8.9	Bl,
	3374.0	8.6	Bl,	3402.0	9.0	Bl,
	3383.0	8.6	Bl,	3417.0	9.7	Bl.
050953 R AURIGAE—						
	3424.0	8.7	Ys,	3449 7	8.5	Br,
	3430.8	8.5	Pt,	3452.6	9.0	Lv,
	3433.5	8.5	M,	3455.7	9.2	Wf,
	3433.8	8.3	Wf,	3456.6	8.6	Pt,
	3434.7	9.1	Lv,	3461.6	9.0	Ya,
	3443.6	8.6	Wf,	3465.6	9.4	Lv.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
051247 T PICTORIS—						
	3363.0	12.0	Bl,	3393.0	10.2	Bl,
	3370.0	11.9	Bl,	3402.0	9.3	Bl,
	3383.0	10.6	Bl,	3417.1	8.2	Bl.
051533 T COLUMBAE—						
	3363.0	10.9	Bl,	3414.1	9.0	Kd,
	3374.0	10.0	Bl,	3417.0	8.1	Bl,
	3383.0	9.6	Bl,	3424.0	8.7	Kd,
	3393.0	9.6	Bl,	3430.0	8.5	Kd.
	3402.0	8.9	Bl.			
052034 S AURIGAE—						
	3403.3	10.0	L,	3433.5	9.6	M,
	3415.6	8.8	B,	3438.4	8.3	L,
	3425.0	9.3	Ys,	3456.6	8.5	Pt,
	3430.8	9.0	Pt,	3461.6	9.2	Ya.
052036 W AURIGAE—						
	3396.4	12.2	Gi,	3437.6	9.6	Gi,
	3430.8	9.8	Pt,	3438.4	10.2	L,
	3431.6	9.8	B,	3444.3	10.1	L,
	3433.5	9.7	M,	3456.6	10.4	Pt.
052404 S ORIONIS—						
	3405.6	10.1	B,	3435.5	12.2	Pt,
	3407.7	10.1	Jb,	3437.6	11.0	B,
	3433.5	[11.4	M,	3456.6	12.0	Pt,
053005a T ORIONIS—						
	3399.3	10.1	L,	3439.5	10.8	Ya,
	3414.6	11.0	Pt,	3441.5	10.2	Pt,
	3427.6	9.5	B,	3442.2	10.2	L,
	3430.8	9.6	Pt,	3446.3	11.3	L,
	3433.5	10.0	M,	3447.4	11.0	L,
	3434.3	10.1	An,	3455.7	10.0	Pt,
	3435.5	9.9	Pt,	3462.5	10.2	Pt,
	3438.3	10.1	L,	3466.5	10.0	Pt,
	3438.5	10.6	Pt,	3468.5	10.1	Pt.
	3439.3	10.3	L,			
053068 S CAMELOPARDALIS—						
	3414.7	8.9	Jb,	3456.7	8 3	Pt.
	3435.5	8.2	Pt,			
053326 RR TAURI—						
	3431.5	12.7	B.			
053531 U AURIGAE—						
	3431.6	13.4	B,	3456.7	13.2	Pt.
	3435.6	13.5	Pt,			
054319 SU TAURI—						
	3396.1	9.6	Ch,	3441.5	9.5	Pt,
	3396.3	9.2	L,	3442.2	9.5	L,
	3403.7	9.5	L,	3442.5	9.6	Pt,
	3404.7	9.5	L,	3442.6	9.6	Br,
	3407.7	9.4	Jb,	3443.6	9.4	Wf,
	3411.6	9.5	B,	3444.6	9.4	Br,
	3413.8	9.6	Pt,	3451.5	9.5	Wf,
	3413.8	9.5	Br,	3451.6	9.5	Br,
	3414.6	9.5	Pt,	3453.6	9.4	Br,
	3427.6	9.7	Br,	3454.8	9.5	Wf,
	3430.8	9.6	Pt,	3455.7	9.5	Wf,
	3431.5	9.6	Pt,	3455.7	9.8	Pt,
	3432.8	9.8	Pt,	3456.6	9.5	Br,
	3433.5	9.4	M,	3456.7	9.7	Pt,
	3433.6	9.5	Br,	3457.5	9.6	Pt.

VARIABLE STAR OBSERVATIONS, December 20, 1922 to February 20, 1923—Continued

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
054319 SU TAURI—Continued.				
	3433.8	9.4 Wf.	3458.7	9.5 Wf.
	3435.5	9.6 Pt.	3459.6	9.4 Wf.
	3436.5	9.5 Pt.	3461.6	9.6 Br.
	3438.3	9.4 L.	3461.6	9.8 Cd.
	3438.5	9.6 Pt.	3462.5	9.5 Pt.
	3439.2	9.5 L.	3466.5	9.6 Pt.
	3439.5	9.5 Pt.	3467.5	9.5 Pt.
	3439.5	9.5 B.	3468.5	9.6 Pt.
	3440.7	9.2 Wf.	3469.8	9.6 Pt.
	3440.7	9.6 Br.		
054331 S COLUMBAE—				
	3363.0	11.0 Bl.	3383.0	11.9 Bl.
	3374.0	11.8 Bl.	3393.0	12.0 Bl.
054615a Z TAURI—				
	3439.5	[12.7 Y.		
054615b RS TAURI—				
	3439.5	8.6 Y.		
054615c RU TAURI—				
	3439.5	[13. Y.		
054620 R COLUMBAE—				
	3363.0	10.5 Bl.	3383.0	11.0 Bl.
	3374.0	10.9 Bl.	3393.0	11.7 Bl.
054907 α ORIONIS—				
	3438.3	0.9 An.	3439.3	0.9 L.
	3438.4	1.0 L.	3446.3	0.8 L.
054920a U ORIONIS—				
	3376.9	8.7 Nk.	3435.6	10.5 Pt.
	3414.1	9.5 Kd.	3441.7	10.5 Lv.
	3415.6	9.4 B.	3452.7	11.3 Lv.
	3433.5	10.6 M.	3465.6	11.8 Lv.
	3434.7	10.5 Lv.	3456.7	10.7 Pt.
054920b UW ORIONIS—				
	3434.7	10.4 Lv.	3452.7	10.9 Lv.
	3441.7	10.4 Lv.	3465.6	10.8 Lv.
054974 V CAMELOPARDALIS—				
	3401.5	14.0 Gi.	3443.6	12.8 Wf.
	3433.8	14.0 Wf.	3456.7	11.9 Pt.
	3437.4	14.0 Gi.	3458.8	11.4 Wf.
	3439.6	13. Y.	3461.5	11.7 Y.
055353 Z AURIGAE—				
	3427.6	10.2 B.	3443.6	10.7 Wf.
	3435.6	10.7 Pt.	3456.7	10.5 Pt.
	3433.8	10.5 Wf.	3458.8	10.5 Wf.
	3442.6	10.8 Ya.		
055686 R OCTANTIS—				
	3363.0	9.5 Bl.	3393.0	10.1 Bl.
	3374.0	9.7 Bl.	3402.0	10.3 Bl.
	3383.0	9.8 Bl.	3417.1	10.9 Bl.
060450 X AURIGAE—				
	3425.0	10.0 Ys.	3440.7	8.5 Br.
	3431.6	8.8 B.	3456.7	8.7 Pt.
	3435.6	8.7 Pt.	3468.6	9.4 Ya.
060547 SS AURIGAE—				
	3370.7	10.5 Ch.	3439.2	[14.5 L.
	3372.2	10.5 Ch.	3439.3	[13.9 Gi.
	3375.2	11.2 Ch.	3439.5	[13.7 B.
	3376.1	11.6 Ch.	3439.9	[14.5 Gi.
	3377.1	[11.6 Ch.	3440.7	14.9 Gi.
060547 SS AURIGAE—Continued.				
	3396.3	[13.0 L.	3441.5	[12.6 Pt.
	3396.4	[13.5 Gi.	3441.7	[13.0 Lv.
	3398.5	[13.8 Gi.	3442.2	[13.3 L.
	3399.3	[13.0 L.	3442.5	[12.6 Pt.
	3400.4	[11.0 L.	3443.7	[14.9 Gi.
	3400.4	14.5 Gi.	3444.3	[13.3 L.
	3401.3	12.3 Gi.	3444.6	[14.5 L.
	3403.2	11.0 L.	3445.7	[14.5 L.
	3403.4	11.7 Gi.	3446.3	[12.4 L.
	3403.7	11.6 L.	3447.3	[12.4 L.
	3404.7	[12.4 L.	3447.7	[13.3 L.
	3405.1	12.0 Ch.	3448.3	[12.4 L.
	3406.1	[12.0 Ch.	3449.6	[12.4 Br.
	3407.6	[13.0 B.	3451.6	[12.4 Gi.
	3407.6	[13.5 Pc.	3453.6	[12.4 Br.
	3407.7	[11.6 Jb.	3454.8	[13.3 Gi.
	3408.6	[11.2 Cu.	3455.7	11.5 Gi.
	3409.6	[12.4 Pt.	3455.7	11.1 Pt.
	3411.6	[13.5 B.	3456.6	10.9 Br.
	3413.8	[12.4 Br.	3456.7	10.8 Pt.
	3413.8	[12.6 Pt.	3457.5	10.9 Pt.
	3414.6	[12.6 Pt.	3457.7	12.8 Lv.
	3421.5	[11.0 Pt.	3458.6	11.4 Gi.
	3425.0	[10.8 Ys.	3459.6	12.2 Br.
	3427.6	[12.4 Br.	3459.7	11.8 Gi.
	3427.7	[14.0 B.	3461.6	[12.6 Br.
	3430.8	[12.6 Pt.	3461.9	[12.6 Pt.
	3431.5	[13.8 B.	3462.5	13.6 Pt.
	3433.8	[14.5 Gi.	3464.7	[13.9 Lv.
	3435.2	[13.3 L.	3465.6	[13.3 Lv.
	3437.3	[13.9 Gi.	3466.5	[12.6 Pt.
	3437.3	[13.5 L.	3467.5	[12.6 Pt.
	3437.5	[13.3 Y.	3468.5	[12.5 Pt.
	3438.3	[14.5 L.	3469.8	[12.6 Pt.
	3438.5	[13.9 Gi.		
061647 V AURIGAE—				
	3439.6	11.9 B.		
061702 V MONOCEROTIS—				
	3435.6	11.3 Pt.	3457.5	10.7 Pt.
063159 U LYNCIS—				
	3439.6	12.4 Y.		
063308 R MONOCEROTIS—				
	3427.6	11.8 B.	3457.5	10.6 Pt.
	3435.6	12.0 Pt.		
063558 S LYNCIS—				
	3435.6	13.0 Pt.	3457.5	13.8 Pt.
064030 X GEMINORUM—				
	3437.4	8.5 Gi.	3437.6	8.3 B.
061707 W MONOCEROTIS—				
	3414.7	10.3 B.	3440.8	10.6 Br.
	3435.6	10.7 Pt.	3457.5	11.0 Pt.
064932 NOVA GEMINORUM #2—				
	3403.7	14.1 L.	3439.3	13.8 L.
065111 Y MONOCEROTIS—				
	3431.6	13.4 B.	3441.7	13.3 Lv.
	3434.7	13.0 Lv.	3454.7	13.5 Lv.
	3435.6	12.8 Pt.	3464.7	13.6 Lv.
	3437.5	13.0 Y.		

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Star	J.D.	Est.Obs.	J.D.	Est.Obs.
065208 X MONOCEROTIS—				
	3400.7	8.4 L,	3447.4	7.7 L,
	3438.4	7.5 L,	3461.6	7.4 Ya.
065355 R LYNCIS—				
	3437.6	13.8 Gi,	3458.8	13.4 Wf.
	3443.7	13.7 Wf,		
070109 V CANIS MINORIS—				
	3431.6	12.2 B,	3440.8	12.7 Br.
070122a R GEMINORUM—				
	3410.7	7.4 Lv,	3443.8	8.2 M,
	3433.8	8.1 Wf,	3457.5	9.0 Pt,
	3435.6	7.7 Pt,	3457.7	9.3 Lv,
	3437.6	7.8 B,	3457.7	9.2 Lv,
	3441.7	8.4 Lv,	3458.8	8.7 Wf.
	3443.7	8.0 Wf,		
070122b Z GEMINORUM—				
	3435.6	12.6 Pt,	3457.5	12.5 Pt,
	3437.6	[12.8 B,	3457.7	12.4 Lv.
	3441.7	12.4 Lv,		
070122c TW GEMINORUM—				
	3410.7	8.4 Lv,	3443.8	8.4 M,
	3437.6	8.0 B,	3457.7	8.3 Lv.
	3441.7	8.4 Lv,		
070310 R CANIS MINORIS—				
	3400.7	7.9 L,	3447.4	7.8 L,
	3438.4	7.5 L,	3453.6	8.0 B.
	3440.6	8.1 B,		
071201 RR MONOCEROTIS—				
	3442.7	13.4 Lv.		
071713 V GEMINORUM—				
	3427.6	10.3 B,	3457.5	8.7 Pt.
	3435.6	9.7 Pt,		
072708 S CANIS MINORIS—				
	3400.7	12.9 L,	3447.4	11.4 L,
	3431.6	12.2 B,	3457.5	10.5 Pt,
	3435.6	11.6 Pt,	3464.7	10.4 Sg.
	3438.4	11.6 L,	3468.6	10.2 Ya.
	3443.8	11.5 M,		
072811 T CANIS MINORIS—				
	3398.1	9.5 Kd,	3437.6	10.7 B,
	3409.0	10.3 Kd,	3443.8	10.0 M,
	3430.0	11.1 Kd,	3457.5	11.6 Pt.
	3435.6	10.6 Pt,		
073173 S VOLANTIS—				
	3363.0	9.3 Bl,	3393.0	8.9 Bl,
	3374.0	9.2 Bl,	3402.0	9.0 Bl,
	3383.1	9.0 Bl,	3417.1	9.2 Bl.
073508 U CANIS MINORIS—				
	3400.7	8.9 L,	3443.8	8.8 M,
	3435.6	8.5 Pt,	3447.4	9.0 L,
	3437.6	8.6 B,	3453.6	8.9 B,
	3438.4	8.5 L,	3457.5	9.2 Pt,
	3439.6	8.8 Y,	3461.6	9.3 Y.
073723 S GEMINORUM—				
	3398.1	9.7 Kd,	3431.6	11.0 B,
	3409.0	9.9 Kd,	3435.6	11.8 Pt,
	3414.9	10.0 M,	3443.8	11.6 M.
	3430.0	11.6 Kd,		
074241 W PUPPIS—				
	3363.0	10.0 Bl,	3393.0	8.0 Bl,
	3374.0	9.1 Bl,	3402.0	8.0 Bl,
	3383.1	8.2 Bl,	3417.1	8.5 Bl.
074323 T GEMINORUM—				
	3398.1	9.3 Kd,	3437.6	10.4 B,
	3409.0	9.5 Kd,	3443.8	10.9 M.
	3414.9	9.3 M,		
074922 U GEMINORUM—				
	3381.2	[12.3 Ch,	3441.5	[13.3 Pt,
	3398.5	[13.7 Gi,	3442.2	[13.3 L,
	3400.4	14.0 Gi,	3442.5	[13.7 Pt,
	3400.7	[13.3 L,	3443.7	14.0 Wf,
	3401.2	[12.3 Ch,	3444.3	[13.3 L,
	3401.5	14.0 Gi,	3444.6	[12.6 Br,
	3403.3	[12.4 L,	3444.6	[13.7 Wf,
	3403.5	[13.7 Gi,	3445.7	[13.7 L,
	3403.7	14.0 L,	3446.3	[12.3 L,
	3404.7	[13.3 L,	3447.4	[12.4 L,
	3413.8	[13.3 Pt,	3448.3	[10.9 L.
	3413.8	[13.0 Br,	3451.6	[12.4 Wf,
	3414.6	[13.3 Pt,	3453.6	[12.8 B,
	3414.7	[13.7 B,	3454.7	[13.7 Lv,
	3414.9	[12.4 M,	3454.8	[13.3 Wf,
	3427.6	14.0 B,	3455.7	[12.3 Pt,
	3427.7	[12.6 Br,	3456.7	[12.3 Pt,
	3430.8	[12.4 Pt,	3457.5	[13.3 Pt.
	3431.6	13.9 B,	3458.8	13.9 Wf,
	3432.8	[13.3 Pt.	3459.6	[13.3 Br.
	3433.9	13.9 Wf.	3459.7	14.0 Wf,
	3435.5	[13.3 Pt,	3461.6	[13.0 Br,
	3436.5	[12.3 Pt,	3461.9	[13.3 Pt.
	3437.3	13.7 L,	3462.5	[13.3 Pt,
	3437.4	13.9 Gi,	3466.5	9.1 Pt,
	3438.4	13.8 L.	3467.5	9.3 Pt,
	3438.5	[13.7 Pt.	3468.5	9.7 Pt.
	3438.5	13.9 Gi,	3468.6	9.7 Y,
	3439.6	[13.7 B.	3469.8	10.4 Pt,
	3439.9	13.8 Wf,	3470.5	10.5 Y.
	3440.7	13.9 Wf.		
081112 R CANCRI—				
	3382.2	10.2 Ch,	3442.6	8.8 Cu,
	3402.2	9.9 Ch,	3447.7	8.9 L,
	3404.7	9.5 L,	3450.6	8.8 Cu,
	3435.6	8.6 Pt,	3457.5	8.3 Pt,
	3439.3	8.7 L,	3461.5	8.7 Cu,
	3439.7	8.8 Cu,	3469.6	8.4 Cu.
081617 V CANCRI—				
	3382.2	8.7 Ch,	3439.7	11.2 B,
	3398.5	9.0 Gi,	3440.8	11.3 Br,
	3402.2	9.2 Ch,	3457.5	12.2 Pt,
	3413.8	9.5 Pt,		
082405 RT HYDRAE—				
	3391.2	8.8 Kd,	3430.0	8.5 Kd,
	3400.7	8.2 L,	3439.3	7.6 L,
	3409.1	8.3 Kd,	3457.5	7.6 Pt.
	3413.8	7.6 Pt,		
082476 R CHAMELEONTIS—				
	3363.0	11.3 Bl,	3383.1	11.7 Bl,
	3374.0	11.4 Bl,	3393.0	12.0 Bl.

VARIABLE STAR OBSERVATIONS, December 20, 1922 to February 20, 1923—Continued

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
083019 U CANCRI—						
	3433.8	14.1	Wf,	3458.8	13.9	Wf.
	3443.7	13.9	Wf,			
083350 X URSAE MAJORIS—						
	3439.6	13.9	B,	3457.7	13.2	Pt.
084803 S HYDRAE—						
	3382.2	9.0	Ch,	3439.6	7.7	Pw,
	3402.2	7.6	Ch,	3440.8	7.7	Br,
	3413.8	7.4	Pt,	3457.7	8.4	Pt,
	3438.8	8.0	M,	3459.6	8.3	Pw.
085008 T HYDRAE—						
	3385.3	9.9	Ch,	3438.4	8.3	L,
	3400.7	10.0	L,	3440.8	8.4	Br,
	3408 2	9.5	Ch,	3447.7	8.1	L,
	3413.8	9.5	Pt,	3457.7	7.6	Pt.
085120 T CANCRI—						
	3385.3	9.3	Ch,	3414.9	9.9	M,
	3404.7	8.9	L,	3439.3	9.3	L,
	3408.2	9.3	Ch,	3457.7	8.7	Pt.
	3413.8	8.8	Pt,			
090024 S PYXIDIS—						
	3413.8	13.2	Pt.			
090151 V URSAE MAJORIS—						
	3439.6	10.6	B.			
090425 W CANCRI—						
	3400.7	8.3	L,	3440.8	8.6	Br,
	3414.9	8.2	M,	3443.7	8.7	Wf,
	3433.9	8.6	Wf,	3447.7	8.4	L,
	3436.6	8.5	Pw,	3458.8	9.0	Wf.
	3439.3	8.2	L,			
091868 RW CARINAE—						
	3363.0	9.5	Bl,	3393.0	10.5	Bl,
	3374.0	10.1	Bl,	3402.1	11.8	Bl.
	3383.1	10.4	Bl,			
092551 Y VELAE—						
	3370.0	[12.4	Bl,	3417.1	11.9	Bl.
	3399.0	12.8	Bl,			
092962 R CARINAE—						
	3363.0	9.2	Bl,	3393.0	8.7	Bl,
	3374.0	9.1	Bl,	3402.1	7.8	Bl,
	3383.1	8.8	Bl,	3417.1	7.0	Bl.
093014 Z HYDRAE—						
	3413.8	11.0	Pt,	3457.7	12.6	Pt.
093178 Y DRACONIS—						
	3439.6	13.8	B,	3461.5	13.7	Y.
	3439.6	13.4	Y,			
093934 R LEONIS MINORIS—						
	3413.8	10.5	Pt,	3440.9	9.5	Br,
	3438.8	10.0	M,	3447.7	8.6	L,
	3439.2	9.3	L,	3457.7	7.7	Pt.
094211 R LEONIS—						
	3385.3	6.7	Ch,	3439.6	8.6	Pw,
	3402.1	8.0	Ch,	3442.9	8.6	Pw,
	3409.8	7.5	Sg,	3446.7	8.4	Sg,
	3413.8	7.1	Pt,	3455.7	9.0	Sg,
	3416.8	8.5	M,	3457.7	8.6	Pt.
	3428.7	8.5	Sg,	3459.6	8.7	Pw,
	3433.8	8.0	Sg,	3464.7	9.0	Sg,
	3436.6	8.5	Pw,	3469.6	10.0	Mh,
	3439.4	9.1	An,			

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
094512 X LEONIS—						
	3403.7	[14.0	L,	3444.6	[13.3	L,
	3439.6	[13.0	L,	3445.7	[13.3	L,
	3442.7	[13.3	L,	3447.7	[13.0	L.
094622 Y HYDRAE—						
	3385.3	7.6	Kd,	3413.8	6.6	Pt,
	3387.3	7.4	Kd,	3457.7	6.7	Pt.
094953 Z VELAE—						
	3363.1	10.8	Bl,	3393.0	11.5	Bl,
	3383.1	11.4	Bl,	3402.1	11.9	Bl.
095421 V LEONIS—						
	3413.8	12.8	Pt,	3457.7	12.4	Pt,
	3433.9	13.3	Wf,	3458.8	13.6	Wf.
	3443.7	13.3	Wf,			
095563 RV CARINAE—						
	3370.0	[12.5	Bl,	3399.0	[13.1	Bl.
100661 S CARINAE—						
	3363.1	5.7	Bl,	3402.1	5.0	Bl,
	3383.1	6.0	Bl,	3417.1	5.0	Bl.
	3393.0	5.2	Bl,			
101058 Z CARINAE—						
	3363.1	11.7	Bl,	3399.0	12.7	Bl.
	3383.1	12.0	Bl,			
101153 W VELAE—						
	3363.1	11.5	Bl,	3393.0	11.6	Bl,
	3383.1	11.4	Bl,	3402.1	11.7	Bl.
103212 U HYDRAE—						
	3385.3	6.1	Kd,	3412.3	5.2	Kd,
	3388.3	6.1	Kd,	3418.3	5.3	Kd,
	3394.3	6.0	Kd,	3419.4	5.2	Kd,
	3400.7	4.8	L,	3420.3	5.2	Kd,
	3402.7	5.1	L,	3422.3	5.1	Kd,
	3404.3	5.8	Kd,	3425.4	5.1	Kd,
	3411.3	5.3	Kd,	3433.3	5.2	Kd.
103769 R URSAE MINORIS—						
	3377.4	11.6	Ch,	3443.7	13.2	Wf,
	3413.8	12.9	Pt,	3457.7	13.0	Pt,
	3433.9	13.4	Wf,	3458.8	13.4	Wf.
104620 V HYDRAE—						
	3386.1	8.6	Bl,	3413.8	8.0	Pt,
	3388.5	9.2	Ch,	3417.1	7.7	Bl,
	3400.7	9.1	L,	3442.7	9.1	L,
	3402.1	8.4	Bl,	3457.7	8.0	Pt.
104628 RS HYDRAE—						
	3386.1	12.1	Bl.			
104814 W LEONIS—						
	3457.7	10.2	Pt,	3458.6	11.0	Y.
110506 S LEONIS—						
	3457.7	12.0	Pt.			
111561 RY CARINAE—						
	3370.0	[13.1	Bl,	3402.1	[13.5	Bl.
111661 RS CARINAE—						
	3370.0	8.9	Bl,	3402.1	8.8	Bl,
	3383.1	8.6	Bl,	3417.1	9.6	Bl.
	3393.0	8.5	Bl,			
111441 X CENTAURI—						
	3386.2	7.2	Bl,	3417.1	7.8	Bl.
	3406.2	7.2	Bl,			

VARIABLE STAR OBSERVATIONS, December 20, 1922 to February 20, 1923—Continued

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
115058 W CENTAURI—				
	3386.2	12.8 Bl.	3402.1	11.1 Bl.
	3393.0	11.4 Bl.	3417.1	10.8 Bl.
115919 R COMAE BERENICES—				
	3433.9	14.2 Wf.	3458.8	[14.0 Wf.
120206 RW VIRGINIS—				
	3385.3	7.3 Kd.	3405.3	7.3 Kd.
121418 R CORVI—				
	3400.7	10.5 L.	3439.7	7.9 L.
	3413.8	9.1 Pt.	3447.7	7.6 L.
	3438.8	8.0 M.	3457.7	7.1 Pt.
122001 SS VIRGINIS—				
	3385.3	7.0 Kd.	3418.3	7.4 Kd.
	3388.3	7.2 Kd.	3420.3	7.5 Kd.
	3390.3	7.3 Kd.	3433.3	7.7 Kd.
	3400.7	6.2 L.	3438.8	7.5 M.
	3404.3	7.4 Kd.	3439.7	7.0 L.
	3408.4	7.3 Kd.	3442.7	6.8 L.
	3412.3	7.4 Kd.		
122532 T CANUM VENATICORUM—				
	3413.8	11.0 Pt.	3443.8	11.5 M.
	3414.8	11.1 M.	3462.7	11.1 Pt.
122803 Y VIRGINIS—				
	3444.7	[14.0 L.		
122854 U CENTAURI—				
	3386.2	10.5 Bl.	3402.1	9.2 Bl.
	3393.0	10.4 Bl.	3417.1	8.2 Bl.
123160 T URSAE MAJORIS—				
	3413.8	12.6 Pt.	3458.8	13.2 Wf.
	3433.9	12.7 Wf.	3462.8	12.9 Pt.
	3443.7	13.0 Wf.		
123307 R VIRGINIS—				
	3400.7	8.9 L.	3447.7	11.9 L.
	3413.8	10.2 Pt.	3462.8	10.0 Pt.
	3439.7	12.1 L.		
123459 RS URSAE MAJORIS—				
	3413.8	12.5 Pt.	3443.7	9.1 Wf.
	3416.8	11.6 M.	3443.8	9.8 M.
	3428.7	11.0 Sg.	3450.6	9.4 Cu.
	3433.6	10.2 Cu.	3455.7	9.0 Sg.
	3433.9	10.2 Wf.	3458.5	10.2 Cd.
	3437.5	9.7 Cu.	3458.8	9.0 Wf.
	3438.8	9.3 M.	3461.5	9.1 Cu.
	3439.6	9.7 Cu.	3462.8	9.4 Pt.
	3439.8	9.3 Sg.	3469.6	10.0 Mh.
	3442.7	9.7 Cu.	3469.7	9.5 Cu.
123961 S URSAE MAJORIS—				
	3403.7	8.5 L.	3439.3	10.5 L.
	3404.8	8.6 Sg.	3443.7	11.0 Wf.
	3413.8	9.5 Pt.	3443.8	11.1 M.
	3416.8	10.0 M.	3447.7	11.4 L.
	3433.6	10.6 Cu.	3458.8	11.3 Wf.
	3434.2	10.5 An.	3462.8	10.8 Pt.
124204 RU VIRGINIS—				
	3462.8	12.0 Pt.		
124606 U VIRGINIS—				
	3413.8	9.4 Pt.	3462.8	8.1 Pt.
	3438.8	8.6 M.		
130212 RV VIRGINIS—				
	3439.9	[13.6 Wf.	3458.9	[13.6 Wf.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
131283 U OCTANTIS—				
	3362.9	9.9 Bl.	3393.0	8.6 Bl.
	3373.9	9.9 Bl.	3402.1	8.0 Bl.
	3382.9	9.3 Bl.	3417.1	7.8 Bl.
132422 R HYDRAE—				
	3386.2	7.0 Bl.	3420.3	6.4 Kd.
	3391.3	7.4 Kd.	3422.3	5.9 Kd.
	3403.7	6.6 L.	3425.4	5.7 Kd.
	3404.3	6.8 Kd.	3426.4	5.6 Kd.
	3405.3	6.8 Kd.	3430.4	5.6 Kd.
	3406.2	6.0 Bl.	3433.3	5.3 Kd.
	3408.4	6.8 Kd.	3437.6	4.9 Gi.
	3411.3	6.6 Kd.	3439.7	4.4 L.
	3412.3	6.5 Kd.	3441.4	4.9 Kd.
	3414.9	6.1 Pt.	3447.7	4.3 L.
	3418.3	5.9 Kd.	3462.8	4.4 Pt.
	3419.4	5.9 Kd.		
132706 S VIRGINIS—				
	3413.8	12.3 Pt.	3439.9	10.4 Wf.
	3433.0	10.5 Sg.	3458.9	9.3 Wf.
	3438.8	9.7 M.	3462.8	8.9 Pt.
133155 RV CENTAURI—				
	3362.9	9.3 Bl.	3402.1	9.4 Bl.
	3373.9	9.3 Bl.	3417.1	9.0 Bl.
	3386.2	9.4 Bl.		
133273 T URSAE MINORIS—				
	3443.7	13.4 Wf.	3458.8	13.5 Wf.
133633 T CENTAURI—				
	3386.2	6.3 Bl.	3421.4	6.0 Kd.
	3406.2	6.2 Bl.	3422.4	6.0 Kd.
	3408.4	6.6 Kd.	3423.3	6.1 Kd.
	3411.4	6.6 Kd.	3425.4	6.0 Kd.
	3412.3	6.4 Kd.	3426.4	5.9 Kd.
	3417.1	5.5 Bl.	3430.4	6.1 Kd.
	3418.3	6.1 Kd.	3433.4	6.3 Kd.
	3419.4	6.0 Kd.	3441.4	6.8 Kd.
	3420.4	6.0 Kd.		
134236 RT CENTAURI—				
	3386.2	10.4 Bl.	3417.1	9.0 Bl.
	3406.2	9.2 Bl.		
134440 R CANUM VENATICORUM—				
	3413.8	10.5 Pt.	3443.8	10.5 M.
	3416.9	10.5 M.	3462.8	8.6 Pt.
134536 RX CENTAURI—				
	3386.2	9.2 Bl.	3417.1	9.8 Bl.
	3406.2	9.8 Bl.		
134677 T APODIS—				
	3362.9	10.2 Bl.	3393.0	11.2 Bl.
	3373.9	10.7 Bl.	3406.2	11.5 Bl.
	3382.9	10.4 Bl.		
135908 RR VIRGINIS—				
	3414.9	13.8 Pt.		
140113 Z BOOTIS—				
	3414.9	9.6 M.	3458.8	11.7 Wf.
	3438.9	11.3 M.		
140512 Z VIRGINIS—				
	3462.8	13.2 Pt.		
140538 RU HYDRAE—				
	3386.2	[11.4 Bl.	3406.2	[12.9 Bl.

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Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
140959 R CENTAURI—						
	3362.9	11.0	Bl.	3402.1	11.7	Bl.
	3373.9	11.3	Bl.	3417.1	10.2	Bl.
	3382.9	11.0	Bl.			
141567 U URSAE MINORIS—						
	3413.8	10.9	Pt.	3432.8	9.8	Pw.
	3426.6	10.2	Pc.	3461.8	9.1	Pt.
141954 S BOOTIS—						
	3403.7	13.2	L.	3443.7	12.4	Wf.
	3413.8	12.6	Pt.	3447.7	12.1	L.
	3437.6	12.8	Gi.	3458.9	11.8	Wf.
	3439.7	12.4	L.	3461.9	11.1	Pt.
142539 V BOOTIS—						
	3403.7	7.5	L.	3420.3	7.8	Kd.
	3412.3	8.2	Kd.	3433.0	8.0	Sg.
	3413.8	7.8	Pt.	3433.4	7.9	Kd.
	3416.9	8.0	M.	3439.7	7.8	L.
	3418.3	7.8	Kd.	3461.9	8.5	Pt.
142584 R CAMELOPARDALIS—						
	3437.4	9.2	Gi.	3458.9	8.6	Wf.
	3443.7	8.8	Wf.	3461.9	8.4	Pt.
	3451.6	8.5	Br.			
143227 R BOOTIS—						
	3413.8	11.6	Pt.	3438.9	9.3	M.
	3433.0	9.6	Sg.	3461.9	7.9	Pt.
144918 U BOOTIS—						
	3437.6	11.6	Gi.	3438.9	11.2	M.
145254 Y LUPI—						
	3368.9	[12.4	Bl.	3406.2	13.2	Bl.
145971 S APODIS—						
	3362.9	10.0	Bl.	3393.0	10.5	Bl.
	3373.9	10 0	Bl.	3402.1	10.2	Bl.
	3382.9	10.0	Bl.	3417.1	10.0	Bl.
150018 RT LIBRAE—						
	3461.9	12.8	Pt.			
150519 T LIBRAE—						
	3461.9	13.5	Pt.			
150605 Y LIBRAE—						
	3403.7	9.6	L.	3447.7	12 1	L.
	3439.7	11.3	L.	3461.9	13.1	Pt.
151520 S LIBRAE—						
	3442.7	11.2	L.			
151714 S SERPENTIS—						
	3439.7	12.6	L.	3458.8	12.9	Wf.
151731 S CORONAE BOREALIS—						
	3412.3	7.2	Kd.	3438.9	7.6	M.
	3414.9	6.6	Pt.	3442.9	7.5	Pw.
	3418.3	7.0	Kd.	3458.8	7.4	Wf.
	3420.3	7.1	Kd.	3461.9	8.1	Pt.
	3433.0	7.0	Sg.	3468.8	8.1	M.
	3433.4	7.2	Kd.			
151822 RS LIBRAE—						
	3406.2	7.3	Bl.	3442.7	9.4	L.
152714 RU LIBRAE—						
	3442.7	12.1	L.	3461.9	10.6	Pt.
152849 R NORMAE—						
	3362.9	8.6	Bl.	3406.2	7.3	Bl.
	3373.9	8.8	Bl.	3417.1	7.3	Bl.
	3386.2	8.6	Bl.			
153215 W LIBRAE—						
	3442.7	14.0	L.	3444.7	12.9	L.
153378 S URSAE MINORIS—						
	3344.0	10.7	Nk.	3443.7	10.7	Wf.
	3377.0	11.2	Nk.	3456.7	11.0	Sg.
	3409.8	10.6	Sg.	3458.9	10.6	Wf.
	3414.9	11.5	Pt.	3461.9	10.4	Pt.
	3427.7	11.4	Sg.			
154428 R CORONAE BOREALIS—						
	3332.0	6.0	Nk.	3435.9	6.1	Pt.
	3343.0	5.8	Nk.	3436.9	6.1	Pt.
	3385.3	6.4	Kd.	3437.6	6.2	Gi.
	3387.3	6.4	Kd.	3438.9	6.2	Pt.
	3390 3	6.3	Kd.	3438.9	6.2	M.
	3393.3	6.5	Kd.	3439.0	6.1	Br.
	3396.2	6.3	L.	3439.7	6.1	L.
	3403.7	6.2	L.	3439.9	6.0	Wf.
	3404.3	6.4	Kd.	3441.4	6.2	Kd.
	3404.7	6.3	L.	3441.8	6.1	Pt.
	3408.4	6.3	Kd.	3442.7	6.0	L.
	3411.3	6.4	Kd.	3442.9	6.5	Pw.
	3412.3	6.4	Kd.	3444.7	6.0	L.
	3413.8	6.1	Pt.	3445.7	6.0	L.
	3414.9	6.0	M.	3455.7	6.1	Pt.
	3414.9	6.2	Pt.	3447.7	6.1	L.
	3418.3	6.4	Kd.	3458.8	6.3	Wf.
	3419.1	6.5	Br.	3459.1	6.1	Br.
	3423.3	6.4	Kd.	3449.1	6.2	Br.
	3426.4	6.2	Kd.	3461.9	6.1	Pt.
	3430.4	6.4	Kd.	3462.8	6.1	Pt.
	3430.8	6.2	Pt.	3465.9	6.2	Pt.
	3432.8	6.5	Pw.	3466.9	6.2	Pt.
	3432.8	6.1	Pt.	3468 8	6.0	M.
	3433.0	6.0	Sg.	3469.9	6.2	Pt.
	3433.3	6.3	Kd.			
154536 X CORONAE BOREALIS—						
	3414.9	9.8	Pt.	3461.9	9.6	Pt.
	3438.9	9.6	M.	3468.8	9.9	M.
	3458.8	9.5	Wf.			
154615 R SERPENTIS—						
	3414.9	10.1	Pt.	3461.9	7.2	Pt.
	3438.9	8.5	M.	3468.8	7.2	M.
154639 V CORONAE BOREALIS—						
	3414.9	7.0	Pt.	3461.9	7.5	Pt.
	3438 9	8.6	M.	3468.8	8.8	M.
	3458.8	8.5	Wf.			
155018 RR LIBRAE—						
	3442.7	14.0	L.	3466.9	12.5	Pt.
	3444.7	14.0	L.			
155823 RZ SCORPII—						
	3438.9	11.8	Pt.	3466.9	9.5	Pt.
160021 Z SCORPII—						
	3442.7	9.5	L.			
160118 R HERCULIS—						
	3466.9	8.4	Pt.			
160210 U SERPENTIS—						
	3466.9	12.8	Pt.			
160625a RU HERCULIS—						
	3414 9	11.7	Pt.	3466.9	12.8	Pt.
	3458.9	8.4	Wf.			

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Star	J.D.	Est.Obs.	J.D.	Est.Obs.
160625 SX HERCULIS—				
	3396.2	8.7 L,	3447.7	8.3 L,
	3414.9	7.7 Pt,	3458.9	8.7 Wf,
	3432.8	8.0 Pt,	3461.9	8.7 Pt,
	3436.9	8.7 Pt,	3465.9	8.2 Pt,
	3438.9	8.2 Pt,	3466.9	8.0 Pt.
	3439.7	7.8 L,		
161122a R SCORPII—				
	3438.9	9.9 Pt,	3466.9	10.7 Pt.
161122b S SCORPII—				
	3466.9	12.7 Pt.		
161122c T SCORPII—				
	3438.9	10.4 Pt,	3466.9	10.8 Pt.
161138 W CORONAE BOREALIS—				
	3414.9	11.2 Pt,	3458.9	9.8 Wf,
	3438.9	9.2 M,	3466.9	9.6 Pt.
161607 W OPHIUCHI—				
	3438.9	11.2 Pt,	3466.9	10.1 Pt.
	3442.7	10.7 L,		
162112 V OPHIUCHI—				
	3438.9	10.0 Pt,	3466.9	10.2 Pt.
162119 U HERCULIS—				
	3414.9	12.0 Pt,	3458.9	9.1 Wf,
	3433.0	11.2 Sg,	3466.9	8.3 Pt.
162319 Y SCORPII—				
	3444.7	[13.0 L.		
162807 SS HERCULIS—				
	3347.9	10.7 Nk,	3447.7	10.1 L,
	3414.9	9.9 Pt,	3466.9	11.7 Pt.
	3439.7	9.4 L,		
162815 T OPHIUCHI—				
	3444.7	13.3 L.		
162816 S OPHIUCHI—				
	3444.7	[13.8 L.		
163137 W HERCULIS—				
	3416.9	9.7 M,	3466.9	8.3 Pt,
	3436.9	8.6 Pt,	3468.8	8.6 M.
	3438.9	8.8 M,		
163172 R URSAE MINORIS—				
	3438.9	10.4 M.		
163266 R DRACONIS—				
	3368.0	8.6 Ch,	3438.9	8.1 M,
	3377.0	8.3 Ch,	3466.8	10.2 Pt.
	3414.9	7.5 Pt,		
164055 S DRACONIS—				
	3414.9	8.5 M,	3468.8	9.4 M.
164319 RR OPHIUCHI—				
	3445.7	13.0 L.		
164715 S HERCULIS—				
	3368.0	8.0 Ch,	3414.9	8.3 Pt,
	3396.2	8.2 Gi,	3466.8	10.1 Pt.
164841 RS SCORPII—				
	3363.0	9.1 Bl,	3382.9	9.9 Bl.
	3373.9	9.6 Bl.		
165030 RR SCORPII—				
	3363.0	5.5 Bl,	3373.9	5.0 Bl.
165202 SS OPHIUCHI—				
	3438.9	8.1 Pt,	3466.9	8.7 Pt.
165631 RV HERCULIS—				
	3371.9	12.5 Nk,	3432.8	12.5 Pt.
165636 RT SCORPII—				
	3368.9	[13.0 Bl.		
170215 R OPHIUCHI—				
	3371.0	7.8 Ch,	3466.9	10.1 Pt.
	3438.9	9.0 Pt,		
170627 RT HERCULIS—				
	3438.9	12.7 Pt,	3466.9	13.2 Pt.
	3458.9	13.6 Wf,		
170833 RW SCORPII—				
	3368.9	[12.5 Bl.		
171401 Z OPHIUCHI—				
	3396.2	8.4 Gi,	3466.9	8.0 Pt.
	3438.9	7.7 Pt,		
171723 RS HERCULIS—				
	3339.0	10.2 Nk,	3386.9	8.6 Nk,
	3341.1	10.0 Nk,	3438.9	8.8 Pt.
	3348.9	10.0 Nk,	3458.9	10.1 Wf,
	3368.9	9.5 Nk,	3466.9	10.3 Pt.
172486 S OCTANTIS—				
	3363.0	9.2 Bl,	3393.0	8.9 Bl,
	3374.0	9.0 Bl,	3402.0	8.7 Bl,
	3383.0	9.2 Bl,	3417.0	9.4 Bl.
172809 RU OPHIUCHI—				
	3438.9	8.8 Pt.	3466.9	9.6 Pt.
173543 RU SCORPII—				
	3363.0	8.7 Bl,	3392.9	9.3 Bl,
	3374.0	8.8 Bl,	3402.0	9.3 Bl.
	3382.9	8.9 Bl,		
174135 SV SCORPII—				
	3368.9	[12.5 Bl.		
174162 W PAVONIS—				
	3369.0	10.0 Bl,	3393.0	8.5 Bl,
	3374.0	9.3 Bl,	3402.0	8.9 Bl,
	3383.0	8.7 Bl,	3417.0	8.9 Bl.
174406 RS OPHIUCHI—				
	3466.9	11.0 Pt.		
175111 RT OPHIUCHI—				
	3438.9	9.1 Pt,	3466.9	9.2 Pt.
175458 T DRACONIS—				
	3377.1	10.8 Ch,	3401.3	10.9 Gi.
175458b UY DRACONIS—				
	3377.1	10.8 Ch.		
175519 RY HERCULIS—				
	3438.9	13.5 Pt,	3466.9	12.3 Pt.
180531 T HERCULIS—				
	3348.9	8.2 Nk,	3442.7	13.0 L,
	3367.1	8.0 Ch,	3458.9	11.8 Wf,
	3400.2	10.1 L,	3466.9	11.4 Pt.
	3438.9	13.1 Pt,		
180565 W DRACONIS—				
	3438.9	10.6 Pt,	3466.9	9.6 Pt.
	3461.5	10.3 Cd.		
180911 NOVA OPHIUCHI 24—				
	3447.7	13.0 L,	3466.9	12.9 Pt.
181031 TV HERCULIS—				
	3400.2	11.2 L,	3445.7	14.0 L.
181103 RY OPHIUCHI—				
	3396.3	8.0 Gi,	3438.9	12.0 Pt.

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Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
181136 W LYRAE—						
	3400.2	9.4	L.,	3444.5	8.3	Wf,
	3437.2	8.7	L.,	3444.7	8.1	L.,
	3438.9	8.1	Pt.,	3458.9	8.2	Wf,
	3440.5	8.3	Wf,	3466.9	8.0	Pt.
182133 RV SAGITTARII—						
	3368.9	12.9	Bl,	3396.0	[11.4	Bl.
182224 SV HERCULIS—						
	3400.2	13.1	L.,	3442.7	10.4	L.,
	3438.9	10.7	Pt.	3466.9	10.7	Pt.
182306 T SERPENTIS—						
	3438.9	9.9	Pt.	3466.9	9.1	Pt.
183149 SV DRACONIS—						
	3437.5	[13.0	Y.			
183308 X OPHIUCHI—						
	3330.9	8.7	Nk,	3438.9	7.2	Pt,
	3341.0	9.0	Nk,	3442.7	7.1	L,
	3349.0	8.3	Nk,	3466.9	7.0	Pt.
	3408.2	7.9	L,			
184134 RY LYRAE—						
	3438.9	15.0	Pt.	3466.9	12.8	Pt.
184205 R SCUTI—						
	3330.9	6.1	Nk,	3402.9	5.7	Kd,
	3341.0	5.6	Nk,	3410.9	5.7	Kd,
	3343.0	5.6	Nk,	3438.9	5.5	Pt,
	3344.0	5.6	Nk,	3439.7	5.3	L,
	3349.0	5.8	Nk,	3441.9	5.6	Pt.
	3364.0	4.9	Ch,	3447.7	6.2	L,
	3371.0	5.5	Ch,	3451.9	6.2	Cd,
	3377.0	5.6	Ch,	3456.9	6.5	Cd,
	3385.9	6.2	Kd,	3458.9	6.6	Cd,
	3386.9	6.0	Nk,	3465.9	6.2	Pt.
	3396.2	6.0	L,	3466.9	6.2	Pt,
	3400.2	5.8	L,	3469.9	6.1	Pt.
	3400.9	5.9	Kd,			
184208 S SCUTI—						
	3331.9	7.2	Nk,	3341.0	6.8	Nk.
184243 RW LYRAE—						
	3438.9	12.2	Pt.	3466.9	12.6	Pt.
184300 NOVA AQUILAE #3—						
	3331.9	10.2	Nk.	3341.1	9.6	Ch,
	3341.0	10.1	Nk,	3403.2	10.1	L,
	3344.0	10.1	Nk,	3445.7	9.9	L,
	3349.0	10.2	Nk,	3465.9	10.3	Pt.
185032 RX LYRAE—						
	3466.9	12.7	Pt.			
185634 Z LYRAE—						
	3445.7	14.8	L.			
185905 V AQUILAE—						
	3331.9	7.2	Nk.	3371.9	7.8	Nk.
	3351.9	7.0	Nk.	3386.9	7.1	Nk.
190108 R AQUILAE—						
	3373.1	11.0	Ch.	3466.9	11.2	Pt.
190529a V LYRAE—						
	3437.5	[12.0	Y.			
190925 S LYRAE—						
	3445.7	[14.5	L.			
190926 X LYRAE—						
	3438.9	9.0	Pt.	3466.9	8.8	Pt.
190933a RS LYRAE—						
	3370.1	10.5	Ch.			
190941 RU LYRAE—						
	3438.9	13.2	Pt.			
190967 U DRACONIS—						
	3366.1	10.8	Ch,	3409.0	9.7	Ch,
	3382.1	9.5	Ch,	3438.9	11.1	Pt,
	3397.1	9.2	Ch,	3466.9	12.3	Pt.
191007 W AQUILAE—						
	3373.1	8.8	Ch.			
191017 T SAGITTARII—						
	3371.1	12.1	Ch.			
191019 R SAGITTARII—						
	3371.0	[11.5	Ch,	3469.9	7.2	Pt.
191033 RY SAGITTARII—						
	3377.0	[10.0	Ch.			
191124 TY SAGITTARII—						
	3369.0	[12.5	Bl.			
191319 S SAGITTARII—						
	3363.0	10.5	Bl,	3392.9	9.9	Bl,
	3374.0	9.9	Bl,	3398.3	10.2	Gi.
	3383.0	9.8	Bl,			
191331 SW SAGITTARII—						
	3369.0	13.0	Bl.			
191350 TZ CYGNI—						
	3437.5	9.8	Y,	3469.9	10.6	Pt.
	3438.9	9.9	Pt,			
191637 U LYRAE—						
	3438.5	10.5	Pt,	3469.9	9.0	Pt.
192928 TY CYGNI—						
	3371.1	9.8	Ch,	3438.9	11.5	Pt.
	3401.0	9.9	Ch.	3469.9	12.8	Pt.
193449 R CYGNI—						
	3407.6	13.3	Pc,	3440.3	13.8	Wf.
	3426.6	13.6	Pc,	3458.6	13.5	Wf.
	3438.5	13.9	Pt,	3469.9	13.2	Pt.
193509 RV AQUILAE—						
	3469.9	13.5	Pt.			
193972 T PAVONIS—						
	3363.0	10.5	Bl,	3383.0	11.8	Bl.
	3374.0	11.3	Bl.	3396.0	12.9	Bl.
194048 RT CYGNI—						
	3370.1	11.3	Ch.	3414.7	9.1	Jb.
	3379.6	10.8	Pw,	3428.7	10.0	Sg.
	3396.3	11.9	Gi,	3438.3	9.0	Gi.
	3407.0	12.0	Ch,	3438.5	8.9	Pt.
	3407.6	11.2	Pc,	3458.5	8.0	Cd,
	3408.6	9.5	Ya,	3469.9	7.8	Pt.
	3411.7	10.2	Sg.			
194348 TU CYGNI—						
	3407.6	13.4	Pc.	3469.9	9.4	Pt.
	3438.5	11.5	Pt.			
194604 X AQUILAE—						
	3469.9	8.7	Pt.			
194632 χ CYGNI—						
	3332.0	5.0	Nk,	3401.2	7.3	An,
	3344.9	5.0	Nk,	3402.9	7.2	Kd,
	3345.9	5.1	Nk,	3404.2	7.3	An,
	3381.0	6.4	Ch,	3404.9	7.4	Kd,
	3385.9	6.5	Kd,	3405.9	7.6	Kd,

VARIABLE STAR OBSERVATIONS, December 20, 1922 to February 20, 1923—Continued

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
194632 χ CYGNI—Continued.						
	3386.9	6.7	Kd,	3407.0	7.0	Ch,
	3386.9	6.8	Nk,	3409.9	7.7	Kd,
	3365.0	5.6	Ch,	3412.9	7.7	Kd,
	3375.1	6.3	Ch,	3415.5	7.8	B,
	3390.9	6.8	Kd,	3429.9	9.2	Kd,
	3394.0	6.9	Kd,	3431.9	9.3	Kd,
	3395.9	6.9	Kd,	3436.5	8.6	Pt,
	3396.1	6.8	Ch,	3469.9	10.3	Pt.
194930 RR SAGITTARII—						
	3363.0	9.8	Bl,	3393.0	7.7	Bl,
	3374.0	9.3	Bl,	3402.0	7.6	Bl.
	3383.0	8.6	Bl,			
195142 RU SAGITTARII—						
	3369.0	10.8	Bl,	3402.0	7.3	Bl,
	3383.0	9.4	Bl,	3417.0	6.0	Bl.
	3393.0	7.8	Bl,			
195553 NOVA CYGNI #3—						
	3347.9	10.6	Nk,	3432.8	10.8	Pt,
	3370.2	10.8	Ch,	3435.5	10.5	Pt,
	3403.2	10.3	L,	3438.5	10.7	Pt,
	3407.0	10.8	Ch,	3441.5	10.5	Pt,
	3409.5	10.8	Pt,	3456.6	10.7	Pt,
	3414.6	10.9	Pt,	3461.9	10.9	Pt,
	3421.5	10.8	Pt,	3465.9	10.8	Pt,
	3431.5	10.7	Pt,	3469.9	10.9	Pt.
195849 Z CYGNI—						
	3398.3	13.9	Gi,	3440.5	9.7	Wf,
	3438.5	9.4	Pt,	3458.6	8.7	Wf,
	3439.3	9.4	Gi,	3469.9	8.2	Pt.
195855 S TELESCOPII—						
	3369.0	13.2	Bl,	3396.0	13.1	Bl.
200212 SY AQUILAE—						
	3400.2	12.2	L,	3440.5	9.3	Wf,
	3437.2	9.9	L,	3469.9	9.1	Pt.
200357 S CYGNI—						
	3407.6	13.9	Pc,	3446.6	12.2	Lv,
	3438.5	12.5	Pt,	3458.6	11.1	Wf,
	3440.5	9.5	Wf,	3469.9	11.0	Pt.
200514 R CAPRICORNI—						
	3400.2	11.0	Gi.			
200647 SV CYGNI—						
	3414.5	8.6	B,	3420.3	9.1	Ys.
200715a S AQUILAE—						
	3381.1	9.8	Ch,	3440.5	9.2	Wf,
	3400.1	11.8	Ch,	3444.5	9.0	Wf,
	3400.3	11.3	Gi,	3469.9	9.3	Pt.
	3435.5	10.5	Pt,			
200715b RW AQUILAE—						
	3435.5	9.2	Pt,	3469.9	9.5	Pt.
200747 R TELESCOPII—						
	3363.0	11.1	Bl,	3383.0	11.1	Bl,
	3374.0	10.9	Bl,	3396.0	11.7	Bl.
200812 RU AQUILAE—						
	3410.5	13.0	Lv.			
200822 W CAPRICORNI—						
	3370.0	[12.8	Bl,	3396.0	[11.6	Bl.
200906 Z AQUILAE—						
	3398.2	11.0	Gi,	3413.9	10.1	Kd.
200938 RS CYGNI—						
	3364.1	7.3	Ch,	3413.9	8.2	Kd,
	3382.1	7.3	Ch,	3424.7	8.2	Sg,
	3389.1	7.4	Ch,	3437.2	8.2	L,
	3398.1	7.6	Ch,	3438.5	7.1	Pt,
	3400.3	7.6	L,	3440.7	7.5	Sg,
	3402.0	8.0	Kd,	3469.9	7.4	Pt.
201008 R DELPHINI—						
	3469.9	11.0	Pt.			
201130 SX CYGNI—						
	3440.5	13.8	Wf,	3458.6	13.6	Wf.
201139 RT SAGITTARII—						
	3363.0	10.2	Bl,	3393.0	8.3	Bl,
	3374.0	9.8	Bl,	3402.0	7.0	Bl,
	3383.0	9.1	Bl,	3417.0	6.8	Bl.
201437b WX CYGNI—						
	3382.1	11.5	Ch,	3440.6	11.9	Wf,
	3398.1	11.8	Ch,	3458.6	12.3	Wf,
	3438.5	12.1	Pt,	3469.9	12.7	Pt.
201647 U CYGNI—						
	3427.5	9.3	B,	3438.5	10.9	Pt.
	3428.7	10.2	Sg,			
202240 U MICROSCOPII—						
	3370.0	[13.0	Bl,	3396.0	[12.5	Bl.
202539 RW CYGNI—						
	3415.0	8.7	Ys.			
202622 RU CAPRICORNI—						
	3401.2	[14.1	Gi.			
202817 Z DELPHINI—						
	3435.5	10.1	Pt,	3469.9	9.4	Pt.
	3440.6	9.6	Wf,			
202946 SZ CYGNI—						
	3409.5	8.8	Pt,	3438.5	9.2	Pt,
	3414.3	10.0	Ys,	3441.5	9.2	Pt,
	3414.5	9.7	B,	3456.6	9.2	Pt,
	3414.6	10.0	Pt,	3461.9	9.6	Pt,
	3421.5	8.9	Pt,	3466.9	8.9	Pt,
	3435.5	9.2	Pt,	3469.9	8.9	Pt.
202954 ST CYGNI—						
	3437.5	10.1	Y,	3458.6	10.1	Wf,
	3438.5	10.2	Pt,	3469.9	10.4	Pt.
	3440.6	10.4	Wf,			
203226 V VULPECULAE—						
	3436.5	9.0	Pt,	3469.9	8.7	Pt.
203429 R MICROSCOPII—						
	3363.0	9.3	Bl,	3383.0	11.5	Bl,
	3374.0	10.4	Bl,	3393.0	[12.2	Bl.
203611 Y DELPHINI—						
	3440.6	[12.4	Wf.			
203816 S DELPHINI—						
	3341.0	9.4	Nk,	3386.8	9.1	Nk,
	3344.0	9.1	Nk,	3405.5	9.0	B.
	3371.9	9.1	Nk,			
203847 V CYGNI—						
	3366.2	8.7	Ch,	3427.5	8.4	B,
	3387.1	9.2	Ch,	3438.5	9.5	Pt.
	3396.1	9.2	Ch,	3440.6	9.5	Wf,
	3407.1	9.2	Ch,	3458.6	9.6	Wf,
	3407.6	9.0	Pc,	3469.9	9.5	Pt.

VARIABLE STAR OBSERVATIONS, December 20, 1922 to February 20, 1923—Continued

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
204016 T DELPHINI—						
	3341.0	11.4	Nk,	3388.1	9.4	Ch,
	3344.0	11.3	Nk,	3396.1	9.4	Ch,
	3365.9	9.9	Nk,	3435.5	11.5	Pt.
	3370.2	9.4	Ch,	3440.5	11.5	Wf.
	3371.9	9.3	Nk,			
204102 V AQUARII—						
	3400.1	9.7	Ch.			
204104 W AQUARII—						
	3371.9	12.2	Nk.			
204215 U CAPRICORNI—						
	3370.0	[13.1	Bl,	3401.2	[13.9	Gi.
204318 V DELPHINI—						
	3398.3	[14.7	Gi,	3440.6	[12.5	Wf.
	3439.2	[12.8	Gi,			
204405 T AQUARII—						
	3352.0	7.9	Nk,	3400.0	8.9	Ch,
	3367.1	7.6	Ch,	3423.9	9.9	Kd.
	3381.0	7.5	Ch,	3429.9	10.1	Kd.
204846 RZ CYGNI—						
	3403.4	13.5	Gi,	3458.6	12.1	Wf,
	3438.5	12.9	Pt,	3469.9	11.8	Pt.
	3440.6	12.3	Wf,			
204954 S INDI—						
	3363.0	11.5	Bl,	3393.0	9.2	Bl,
	3374.0	10.4	Bl,	3402.0	8.8	Bl.
	3383.0	10.1	Bl,			
205017 X DELPHINI—						
	3440.6	[13.3	Wf.			
205923 R VULPECULAE—						
	3381.1	11.9	Ch,	3431.9	8.4	Kd,
	3398.3	11.5	Gi,	3436.5	7.8	Pt,
	3401.1	11.1	Ch,	3438.2	7.8	Gi.
	3401.9	11.6	Kd,	3443.5	7.4	Wf,
	3413.9	9.5	Kd,	3455.5	7.5	Wf.
	3426.9	8.5	Kd,	3469.9	8.0	Pt.
	3429.9	8.4	Kd,			
210134 V CAPRICORNI—						
	3363.0	12.1	Bl,	3401.3	[13.1	Gi,
	3396.0	[11.7	Bl,			
210129 TW CYGNI—						
	3437.5	10.3	Y,	3458.6	10.8	Wf.
	3443.6	10.4	Wf,			
210221 X CAPRICORNI—						
	3370.0	[12.7	Bl,	3396.0	[12.4	Bl,
	3377.0	12.3	Nk,	3401.3	[12.7	Gi.
210382 X CEPHEI—						
	3443.6	13.8	Wf,	3458.6	13.4	Wf.
210504 RS AQUARII—						
	3423.9	[11.1	Kd,	3437.2	[11.5	L.
210812 R EQUULEI—						
	3435.5	10.4	Pt,	3443.5	10.5	Wf.
210868 T CEPHEI—						
	3364.1	10.3	Ch,	3430.5	8.5	Ya,
	3397.1	10.0	Ch,	3438.3	7.9	L.
	3403.3	10.3	L,	3442.6	8.4	Ya,
	3407.5	9.0	B,	3444.3	8.0	L,
	3409.5	8.8	Pt,	3455.7	8.0	Sg,
	3409.8	9.5	Sg,	3457.5	6.8	Pt.
	3426.0	8.1	Ys,	3464.7	7.4	Sg,
	3428.7	9.0	Sg,			

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
211614 X PEGASI—						
	3409.5	11.0	Pt,	3439.3	12.5	Gi,
	3437.5	13.0	Y,	3443.5	13.9	Wf.
211615 T CAPRICORNI—						
	3363.0	9.6	Bl,	3393.0	11.2	Bl,
	3374.0	10.1	Bl,	3402.0	11.5	Bl,
	3381.0	11.0	Ch,	3407.5	11.8	B,
	3383.0	10.6	Bl,	3417.0	[10.5	Bl.
212030 S MICROSCOPII—						
	3363.0	9.5	Bl,	3393.0	10.3	Bl,
	3374.0	9.5	Bl,	3402.0	11.3	Bl,
	3383.0	9.8	Bl,	3417.0	[12.4	Bl.
212814 Y CAPRICORNI—						
	3370.0	12.8	Bl,	3396.0	[12.6	Bl.
213244 W CYGNI—						
	3385.9	6.4	Kd,	3413.9	6.2	Kd,
	3390.3	5.7	L,	3416.9	6.4	Kd,
	3390.9	6.4	Kd,	3418.9	6.4	Kd,
	3394.0	6.4	Kd,	3419.9	6.5	Kd,
	3395.9	6.3	Kd,	3422.9	6.5	Kd,
	3402.0	6.3	Kd,	3425.9	6.5	Kd,
	3404.9	6.3	Kd,	3433.9	6.4	Kd,
	3405.9	6.3	Kd,	3437.3	5.7	L,
	3408.0	6.3	Kd,	3437.9	6.5	Kd,
	3409.9	6.4	Kd,	3438.2	6.3	An,
	3412.0	6.2	Kd,	3445.7	5.7	L.
213678 S CEPHEI—						
	3407.5	7.4	B,	3442.6	8.7	Ya,
	3409.5	7.4	Pt,	3451.6	8.5	Br,
	3430.6	8.5	Ya,	3457.5	8.5	Pt,
	3439.5	8.6	Wf,	3458.6	9.1	Wf.
	3442.6	8.9	Lv,			
213753 RU CYGNI—						
	3371.2	8.3	Ch,	3409.5	8.3	Pt,
	3400.1	8.3	Ch,	3457.5	8.5	Pt.
213843 SS CYGNI—						
	3331.0	11.9	Nk,	3433.6	11.9	Br,
	3339.0	10.6	Nk,	3435.2	12.0	L,
	3341.0	9.8	Nk,	3435.5	11.8	Pt,
	3343.9	9.2	Nk,	3436.5	11.9	B,
	3347.0	8.7	Nk,	3436.5	11.7	Pt,
	3347.9	8.4	Nk,	3437.3	11.9	L,
	3349.0	8.4	Nk,	3437.3	11.6	Gi,
	3349.9	8.3	Nk,	3437.5	11.0	Y,
	3351.2	8.7	Nk,	3438.3	10.3	L,
	3351.9	8.8	Nk,	3438.3	10.9	Gi,
	3356.0	9.0	Nk,	3438.3	10.8	L,
	3371.1	11.7	Ch,	3438.5	9.9	Pt,
	3371.9	11.5	Nk,	3439.2	8.9	L,
	3372.1	11.7	Ch,	3439.3	9.2	Gi,
	3373.1	11.8	Ch,	3439.3	8.7	L,
	3375.4	12.0	Nk,	3439.5	8.7	Ya,
	3375.1	11.8	Ch,	3439.5	8.7	Wf,
	3376.1	11.6	Ch,	3439.5	9.0	Pt,
	3385.1	10.7	Ch,	3439.5	8.8	B,
	3386.2	10.4	Ch,	3439.7	8.5	L,
	3387.2	9.6	Ch,	3440.5	8.4	B,
	3388.1	9.4	Ch,	3440.6	8.5	Wf,
	3389.1	9.2	Ch,	3440.6	8.4	Br,
	3390 1	8.8	Ch,	3440.7	8.2	Sg,
	3390.3	8.4	L,	3441.5	8.4	B,

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Star	J.D.	Est.Obs.	J.D.	Est.Obs.
213843 SS CYGNI—Continued.				
	3391.1	8.7 Ch,	3441.5	8.6 Pt,
	3391.9	9.0 Kd,	3442.2	8.4 L,
	3391.9	9.1 Kd,	3442.5	8.6 Pt,
	3392.1	8.6 Ch,	3442.5	8.2 Lv,
	3393.1	8.7 Ch,	3442.6	8.3 Br,
	3394.1	9.0 Ch,	3443.6	8.2 Wf,
	3395.1	9.3 Ch,	3443.6	8.3 Br,
	3396.1	9.6 Ch,	3444.2	8.4 L,
	3396.2	10.1 L,	3444.2	8.5 L,
	3397.1	11.0 Ch,	3444.5	8.2 Wf,
	3398.1	11.5 Ch,	3444.5	8.3 Lv,
	3399.3	11.8 L,	3444.6	8.5 Br,
	3400.3	12.1 L,	3445.7	8.3 L,
	3401.0	11.9 Kd,	3445.7	8.4 Sg,
	3401.1	11.7 Ch,	3446.3	8.3 L,
	3402.0	12.0 Kd,	3446.5	8.6 Lv,
	3403.1	11.7 Ch,	3446.5	8.4 Lv,
	3403.2	12.1 L,	3447.3	8.3 L,
	3403.6	11.3 Br,	3447.5	8.4 Cd,
	3405.1	11.2 Ch,	3447.7	8.3 L,
	3405.6	11.1 B,	3448.3	8.4 L,
	3406.1	11.2 Ch,	3448.6	8.8 Br,
	3407.1	11.2 Ch,	3449.6	8.7 Br,
	3407.6	11.2 B,	3449.6	8.8 Lv,
	3407.6	10.7 Pc,	3451.5	10.3 Lv,
	3407.7	11.6 Jb,	3451.5	8.6 Wf,
	3408.1	11.7 Ch,	3451.6	9.2 Br,
	3408.6	11.2 Ya,	3452.5	10.8 Lv,
	3409.1	11.8 Ch,	3453.6	10.2 Br,
	3409.5	11.5 Pt,	3454.5	11.1 Lv,
	3410.6	11.6 Lv,	3454.7	10.4 Sg,
	3411.6	11.4 B,	3456.5	10.9 Cd,
	3413.8	11.3 Br,	3456.6	10.8 Pt,
	3413.9	11.7 Kd,	3457.5	11.1 Pt,
	3414.6	11.6 Pt,	3458.5	11.0 Cd,
	3415.5	11.3 B,	3458.6	11.0 Wf,
	3418.6	11.8 B,	3459.6	11.4 Wf,
	3421.5	11.8 Pt,	3459.6	11.6 Br,
	3423.9	11.9 Kd,	3461.5	11.4 Cd,
	3424.5	11.6 B,	3461.5	11.5 Y,
	3425.0	[10.2 Ys,	3461.9	11.8 Pt,
	3426.9	12.0 Kd,	3462.5	11.7 Pt,
	3427 5	11.7 B,	3465.9	11.9 Pt,
	3427.6	11.7 Br,	3466.9	11.8 Pt,
	3429 9	11.8 Kd,	3467.5	11.8 Pt,
	3431.5	11.7 B,	3468.5	11.7 Pt,
	3431.5	11.8 Pt,	3469.9	11.7 Pt.
	3431.9	11.9 Kd,		
213937 RV CYGNI—				
	3409.5	6.5 Pt,	3457.5	6.5 Pt.
	3414.5	7.8 B,		
214024 RR PEGASI—				
	3386.0	9.2 Kd,	3413.9	10.3 Kd,
	3387.9	9.2 Kd,	3427.5	11.3 B,
	3394.9	9.3 Kd,	3429.9	11.5 Kd,
	3401.9	9.7 Kd,	3440.6	12.3 Wf,
	3409.0	10.0 Kd,	3456.5	12.6 Pt,
	3409.5	9.6 Pt,	3458.6	13.0 Wf.
214247 R GRUIS—				
	3363.0	8.7 Bl,	3393.0	8.7 Bl,
	3374.0	8.6 Bl,	3402.0	8.9 Bl,
	3383.0	8.5 Bl,	3417.0	9.2 Bl.
215605 Y PEGASI—				
	3409.5	11.0 Pt,	3443.5	12.7 Wf.
215717 U AQUARII—				
	3409.5	11.8 Pt.		
215934 RT PEGASI—				
	3385.1	10.4 Ch,	3409.5	10.0 Pt,
	3386.1	10.0 Kd,	3413.9	10.1 Kd,
	3388.0	10.1 Kd,	3414.6	10.4 B,
	3395.0	10.0 Kd,	3427.7	10.6 Sg,
	3401.9	10.4 Kd,	3431.9	11.3 Kd,
	3407.1	10.7 Ch,	3442.6	12.0 Lv.
	3407.7	10.4 Sg,		
220133a RY PEGASI—				
	3409.5	8.1 Pt,	3427.6	8.7 B.
220133b RZ PEGASI—				
	3456.5	9.3 Pt.		
220412 T PEGASI—				
	3398.4	[13.7 Gi.		
220613 Y PEGASI—				
	3385.2	10.9 Ch,	3410.9	11.7 Kd,
	3398.4	10.9 Gi,	3414.6	11.9 B.
220714 RS PEGASI—				
	3398.4	12.4 Gi,	3414.6	12.8 B.
	3410.9	13.0 Kd.		
221722 RT AQUARII—				
	3426.9	10.2 Kd.		
222129 RV PEGASI—				
	3414.6	[12.5 B,	3440.5	[12.5 B.
222439 S LACERTAE—				
	3409.5	8.1 Pt,	3446.3	9.4 L,
	3436.6	8.4 B,	3456.5	9.0 Pt.
	3437.3	8.4 L,		
223841 R LACERTAE—				
	3403.4	14.6 Gi,	3437.3	[13.5 L.
225914 RW PEGASI—				
	3407.7	10.5 Sg,	3427.7	11.4 Sg.
	3427.6	11.1 B,		
230110 R PEGASI—				
	3409.5	11.6 Pt,	3428.7	11.0 Sg,
	3426.0	10.5 Ys,	3456.5	10.4 Pt.
230759 V CASSIOPEIAE—				
	3401.5	10.4 Gi,	3436.6	12.3 B,
	3407.5	10.7 B,	3437.5	12.0 Gi,
	3407.7	11.0 Sg,	3456.5	11.8 Pt.
	3409.5	11.1 Pt,		
231425 W PEGASI—				
	3403.3	9.1 L,	3442.6	8.8 Lv,
	3437.3	8.7 L,	3448.3	8.8 L.
231508 S PEGASI—				
	3409.5	12.6 Pt,	3456.5	11.5 Pt.
	3439.6	11.7 B,		

VARIABLE STAR OBSERVATIONS, December 20, 1922 to February 20, 1923—Continued

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
233335 ST ANDROMEDAE—				
	3382.2	9.2 Ch,	3420.0	9.0 Ys,
	3402.2	8.5 Ch,	3439.5	9.2 Wf,
	3409.5	8.4 Pt,	3456.5	8.8 Pt,
	3418.6	8.8 B,	3458.7	8.9 Wf.
233815 R AQUARII—				
	3367.1	9.3 Ch,	3413.9	8.9 Kd,
	3380.2	9.3 Ch,	3423.9	8.3 Kd,
	3397.1	9.2 Ch,	3429.9	7.8 Kd,
	3391.9	9.6 Kd,	3437.9	6.4 Kd,
	3407.7	9.0 Jb,	3442.5	7.0 Cu,
	3408.6	9.1 Ya,	3447.5	5.8 Cu,
	3409.5	9.1 Pt,	3456.5	6.2 Pt.
233956 Z CASSIOPEIAE—				
	3440.6	13.4 Wf,	3458.7	13.2 Wf.
235053 RR CASSIOPEIAE—				
	3401.4	10.8 Gi,	3436.6	11.3 B,
	3407.6	11.2 B,	3437.5	11.1 Gi.
235200 V CETI—				
	3370.0	13.4 Bl,	3417.0	10.1 Bl,
	3396.0	11.7 Bl,	3423.9	9.7 Kd,
	3396.3	12.0 L,	3437.2	9.8 L,
	3396.3	12.2 Gi,	3437.3	9.5 Gi,
	3402.0	11.5 Bl,	3448.3	9.8 L.
235350 R CASSIOPEIAE—				
	3396.5	6.6 Gi,	3461.6	7.8 Ya.
	3414.6	7.3 B,		
235525 Z PEGASI—				
	3409.5	10.8 Pt,	3429.9	10.2 Kd,
	3414.0	10.6 Kd,	3456.5	8.9 Pt.
235715 W CETI—				
	3414.0	9.5 Kd,	3437.3	9.1 Gi.
	3423.9	9.1 Kd,		
235855 Y CASSIOPEIAE—				
	3401.4	13.6 Gi,	3439.6	12.4 B.
235939 SV ANDROMEDAE—				
	3409.5	12.7 Pt,	3456.5	13.6 Pt,
	3437.5	[13.1 Y,	3461.5	[13.1 Y.

	Total Observations	Observers
Dec. 20—Jan. 20	1157	22
Jan. 20—Feb. 20	1306	18
	2463	23

It will be noted that a change in form has been adopted for the present report, which will be continued for the future if it meets with approval. Two important features of this change should be called to attention; the observations are arranged in order of time reading down the columns instead of across the lines as heretofore. And the symbol < has been discarded in favor of the bracket, [, to indicate that the variable was not seen but that it must have been fainter than the indicated magnitude. Observers, however, should continue to employ the former symbol in their manuscript reports, to avoid error.

The telescope committee has assigned the Pickering 6-inch reflector to Mr. William H. Christie of Victoria, B. C., and the 3-inch refractor to Mr. P. R. Allen of Auburndale, Mass. Mr. W. F. H. Waterfield has suffered the deplorable loss of his home by fire, which may render his active cooperation difficult for the immediate future. The following observers contributed to this double report: Messrs. Ancarani "An" 3, Baldwin "Bl" 6, Bouton "B", Brocchi "Br" 6, Chandler "Cd" 3, Chandra "Ch" 3, Cunningham "Cu", Ginori "Gi" 9, Jacobsen "Jb" 5, Kanda "Kd" 2, Lacchini "L" 5, Leavenworth "Lv" 10, Marshall "Mh", McAteer "M" 5, 13, Nakamura "Nk" 4, 10, Peltier "Pt" 6, Proctor "Pc" 12, Skaggs "Sg" 5, Waterfield "Wf" 12r, Watson "Pw" 6, Yalden "Ya" 4, Yamasaki "Ys" and Miss Young "Y" 8.

HOWARD O. EATON, Recording Secretary.

GENERAL NOTES AND COMMUNICATIONS.

We are sorry to have to cut down our General Notes so much this month, for lack of space. Our readers will notice that this time, as frequently before, we have printed 80 pages instead of 64 in order to include long important articles without delay.

P. van de Kamp, chief assistant at the Kapteyn Astronomical Laboratory, Groningen, Holland, will spend a year at the Leander McCormick Observatory, University of Virginia. He will devote his time to the measurement of proper motions of the Boss stars on the McCormick parallax program. In this he will work in coöperation with Dr. Harold L. Alden.

Dr. Leon Campbell, of Harvard College Observatory delivered a most interesting lecture on February 19, in the Lecture Hall of the Brooklyn Institute, on "Variable Stars and the Amateur Observer." It was illustrated with many new and striking slides.

The Bruce Gold Medal of the Astronomical Society of the Pacific, was awarded, at the January meeting of the Society, to Dr. Edouard B. Baillaud, director of the Observatory of Paris, for distinguished services to Astronomy. The address of the retiring president, E. P. Lewis, gives a brief account of the life and work of Dr. Baillaud (*Pub. Astr. Soc. of the Pacific*, Vol. XXXV, p. 2, February, 1923).

Eclipse Notes. — Arizona astronomers this year will study the total eclipse of the sun in Old Mexico. Dr. A. E. Douglass, director of Steward Observatory at the University of Arizona, is preparing to head an expedition to the ranches near Hermosillo, capital of Sonora, where advantageous locations can be found for the observations.

It might interest you to know that Arizona amateurs also are planning a trip into the wilds of the Sonora desert and will take along such equipment as they can gather for the purpose of studying and recording the phenomenon.

One group is planning to leave Douglas, on the border, and drive the 160 miles by automobile. They will be equipped with a 3-inch glass at least, but hope to take other equipment if they can secure it. There is plenty of time ahead for other amateurs to consider joining this expedition and, no doubt, correspondence with either myself or Mr. Jack O'Connor, Box 258, Douglas, Ariz., might lead to enjoyable and profitable joining of forces. There is also the possibility that equipment might be loaned to these amateurs for their trip—under certain guarantees, of course, that the material would be well cared for and returned safely.

LYLE ABBOTT.

Prescott, Ariz., March 7, 1923.

Vatican Observatory Publications Lost at Sea.— Fifteen packages of the Vatican Observatory publications, which were shipped October 14, 1922, directed to places in the United States, Canada, and Mexico, were lost at sea with the steamer *Matilde Pierce* on account of a fire which had broken out on it. The packages contained Supplementary Charts to the Atlas Stellarum Variabilium, a first installment of the Catalogue of Bright and Obscure Nebulae, and Part II of the Miscellanea Astronomica. Duplicate packages are now being shipped to the same destinations. This unfortunate accident explains why the places concerned will receive these publications half a year later than others.

WILLIAM F. RIGGE.

A Remarkable Stellar Outburst?—The newspapers announced early in March that the star β Ceti had suddenly increased two magnitudes. The following note by Director Frost of the Yerkes Observatory shows that the observers there could detect no noticeable change in the star, although observations can now be made only with great difficulty because β Ceti is getting too nearly in line with the sun. Professor Chant, editor of the *Journal of the Royal Astronomical Society of Canada*, suggests that the well-known variable star Omicron (o) Ceti may have been confused with β Ceti. The former has recently been at its maximum.

According to the *English Mechanic* of March 9, 1923, the announcement came from Athens and was based upon observations by an English lad named Abbott, who, although only fourteen years of age, is a member of the French Astronomical Society.

Regarding Beta Ceti. — Telephonic inquiries from some of the national press agencies and newspapers in Chicago on the afternoon of February 27 advised us that a certain star in the constellation Cetus had risen to the first magnitude. The purport of the dispatch was that the French Academy had announced that a cataclysm had occurred in the constellation Cetus. Toward the end of the afternoon another request from the press agencies for confirmation of the report indicated that the star was Beta Ceti and that its rise in magnitude had been quite recent.

The star was then picked up by Mr. Van Biesbroeck in the field of the 40-inch telescope and examined by him and by Mr. Lee an hour before sunset. Its color was noted by them to be yellowish, but they did not get the impression that it was particularly brilliant. The photometric magnitude of the star is 2.24, and its photographic magnitude 3.24, as given in the Henry Draper Catalog, Harvard Annals, Volume 91. Hence, its color index is exactly 1 magnitude. Its spectral type is K0. It is called G6 by Adams and Joy, and we find its spectroscopic parallax is 0".042. Its radial velocity is 13.5 km/sec. as quoted by Voûte from results at three observatories.

It was not possible to observe the star spectrographically that evening, because an extension of the observing chair had to be built in order to reach the horizon, and the star set less than an hour after the sun. Its declination, —18° 24′ (1925), contributed to the difficulty of observing it in this latitude. On February 28 clouds prevented any observations, but preparations were complete with the Bruce spectrograph and with the Zeiss U-V prismatic camera in the Snow dome. On March 1 the sky was thick with haze at sunset and there were some clouds near the position of the star. Observations were attempted by Mr. Struve and Mr. Sullivan with the Bruce spectrograph attached to the 40-inch telescope, and by Mr. Parkhurst and Mr. Yamamoto with the U-V camera at the Snow dome. Mr. Parkhurst made three exposures with the 15° objective prism, but the brightness of the sky completely fogged the plates so that no trace of the spectrum could be seen. It was impossible to get an exposure with the Bruce spectrograph, owing to the difficulty of bringing the star on the slit, as it was hardly visible in the long-focus finder. The brightness of the star was so cut down by the thick atmosphere and its low altitude that an exposure of at least one hour would probably have been necessary with one-prism dispersion, while the brightness of the twilight would have given a sky spectrum in five minutes. All of the observers noted the very red color of

the star, which may have been entirely a result of its position at the horizon. On the evening of March 2 the sky was about the same in the southwest and the attempt was repeated. Mr. Parkhurst made two exposures of one minute and two minutes, respectively, with the U-V camera, but again the plates were entirely fogged, so that no spectrum of the star could be seen. The Bruce spectrograph was carefully manipulated by Mr. Struve and Mr. Sullivan, but it was again impossible to see the star in the long-focus finder and to get it on the slit. From its appearance in the 4-inch finder it is estimated that an exposure of towards two hours would have been necessary to get the spectrum at that altitude.

None of our observers could venture an estimate as to the brightness of the star, i. e., whether it was above its normal brightness or not. Accordingly, as the result of our efforts, we are unable to express an opinion, in confirmation or otherwise, of the press reports from Paris, and we shall await with interest precise information through scientific channels.

Beta Ceti is situated nearly 75° from the Milky Way and hence outside the region in which a nova might be expected. So far as we know it has never been suspected of variability in its light.

EDWIN B. FROST.

Yerkes Observatory, March 6, 1923.

Occultation of Venus, January 13, 1923.—The following observation of the occultation of Venus may be worth recording. The immersion was missed on account of clouds, but the sky cleared partially about ten minutes before emersion, and though there was thin cloud present the seeing was fair, or better than was expected at the low altitude.

	Greenwich Mean Time		
	h	m	s
First cusp	0	11	44.1
Second cusp		13	14.4
Second limb		13	24.4

The instrument was the 40-cm equatorial, power 120; estimates by eye and ear with a chronometer. The first time was estimated to the nearest half-second, and the other times to the nearest second.

JOEL STEBBINS.

Washburn Observatory, Madison, Wisconsin.

The Spectrum of Venus. — In the *Lowell Observatory Bulletin*, No. 84, Director V. M. Slipher gives an account of attempts made in 1908 and 1921 at the Lowell Observatory to secure photographs of the spectrum of Venus which should reveal something as to the character of the planet's atmosphere. In 1921 the photographs were taken at a time when the absorption bands in the solar spectrum due to water vapor in the earth's atmosphere were at a minimum at Flagstaff. The plates were taken at a wide range of altitudes, and indicate greater absorption at greater zenith distances, but the spectrograms of Venus when compared with those of the sun at the same altitudes show no accentuation of the absorption bands due either to moisture or oxygen.

Dr. Slipher's closing paragraph is, "Hence, this study shows no evidence that by oxygen, water-vapor or other substances, does the atmosphere of Venus selectively absorb the sunlight she reflects us, and so it leaves this remarkable planet a challenge to further study."

The Eclipse of September 21, 1922. — In *Publications of the Astronomical Society of the Pacific* for February, 1923, is given a very interesting and full account of the Crocker Eclipse Expedition to Wallal, West Australia, to observe the total eclipse of the sun on September 21, 1922. The account is in the form of a lecture, delivered by Professor W. W. Campbell in San Francisco, on January 1, 1923, under the auspices of the Astronomical Society of the Pacific, revised and modified to serve as a detailed record of the expedition.

Making Astronomy Popular. —One of the aims of POPULAR ASTRONOMY is to make astronomy popular, and for that reason we are always pleased to notice anything calculated to foster those aims.

While it is true that many of the world renowned astronomers are college bred, the records of history tell us of a number of famous astronomers, who had not been so fortunate as to be given more than a common school education, after which they had occupied themselves at some ordinary vocation, but who later in their lives became famous astronomers.

AN OBSERVATORY ON THE ROOF OF A Y. M. C. A. BUILDING.

In the Social Hall of a Y. M. C. A. building in most any large city, one can see during any week day afternoon, a crowd of from 50 to 100 roistering and hilarious boys. Who knows but among them there is a future President, and there might as well be a future famous astronomer, if only his interest and love for that science can be aroused.

It was that sort of an idea which impelled Mr. A. F. Schroeder of Cleveland, to present a 5½-inch Alvan Clark Equatorial Telescope and the dome for a suitable Observatory, to the West Side Branch of the Cleveland Y. M. C. A. He also presented them with a Balopticon and about 80 astronomical slides.

This Observatory is now completed and in use. It is probably true that this is the only Observatory in the world placed on the roof of a Y. M. C. A. building.

The telescope is mounted on a heavy concrete pedestal, which in turn rests on a thick concrete pad about eight feet in diameter. The eye-pieces have magnifying powers ranging from 50, 60, 80, 120, 240, to 400 diameters, and there is a diagonal with dark glasses for observing the sun.

By means of this equipment, Mr. M. D. Crackel, the genial Master of that Branch of the Y. M. C. A., takes little journeys, every little while, among the wonders of the sky, accompanied by a crowd of boys between the ages of ten and eighteen years.

The Solar Eclipse of September 10.—The State Department transmits to the Smithsonian Institution a communication from Mr. Leighton Hope, consul in charge at Ensenada, Mexico, on the conditions at Ensenada with respect to the observation of the total solar eclipse of September 10, 1923. An abstract of the consul's report is as follows:

The town is on the west coast of Lower California. The eclipse is total at Ensenada at 2:02 P. M. Weather conditions there promise to be excellent. The town may be reached from San Diego by auto stage line over a rough but passable route in about five hours. If reached by sea it would probably require a special vessel, as the two Mexican lines carrying passengers and freight from San Francisco and Los Angeles have somewhat irregular schedules at intervals of something like two weeks. Various points of vantage along the path of totality can be reached from Esenada by automobile or by burro pack train, but facilities for such transportation are extremely limited there so that transportation should be arranged for in advance, probably at San Diego.

Ensenada is a small village with no hotel, one or two small rooming houses and a few Chinese restaurants. Camping out, however, would be pleasant. Meat, fresh vegetables, fruit and melons can be had at that season at reasonable prices and in sufficient quantity. Other supplies should be imported. Servants, cooks and ordinary labor will be difficult to obtain on the ground.

The town of Tia Juana, Mexico, near San Diego, has an unsavory reputation and it is not unlikely that criminals from there might visit Ensenada at the time of the eclipse, so that each member of observation parties should have a passport or other documents showing his nationality, identity and the purpose for which he is in Ensenada. Local authorities express themselves as anxious to do everything possible for the comfort of the guests on this occasion.

Provision for admission of apparatus duty free would have to be effected through the national government at Mexico City.

C. G. Abbot, *Assistant Secretary.*

From *Science*, March 23, 1923.

Newcomb-Engelmann, Populaere Astronomie, 7th edition, 1922 (Wilhelm Engelmann, Leipzig). A year ago the 6th edition of this valuable book was published under the editorship of Professor Ludendorff, the director of the Potsdam Observatory. The new edition under the same editor is similar to the preceding one except for minor corrections in the text which could be made without changing the paging and an appendix of 19 pages which contains the additional material necessary to bring the information down to November, 1922. Astronomy is developing so rapidly that frequent revisions of books of this character are a necessity if they are to maintain their high position. The publishers are to be congratulated that they are so successful in this respect. As noted in a preceding number an English translation of this 7th edition is being made in this country. It should prove to be of great value to those who find it difficult to read the original.